SUGARBEET RESEARCH

1983 REPORT

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FOREWARD

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SUGARBEET RESEARCH

1983 Report

Section A

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ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION, 1983

COHEN, S., J. E. DUFFUS, R. C. LARSEN, H. Y. LIU, and R. A. FLOCK. Purification, serology, and vector relationships of squash leaf curl virus, a whitefly-transmitted geminivirus. Phytopathology 73:1669-1673. 1983.

A complex of whitefly-borne disease agents has been isolated from field cucurbits in the southwestern desert of the USA. One component of the complex, squash leaf curl virus (SLCV) alone caused severe stunting and leaf curl symptoms on leaves of all cultivars of Cucurbita maxima, C. moschata, and C. pepo that were tested, and a green mosaic and leaf distortion of Phaseolus vulgaris. The virus was purified by differential centrifugation after clarification of leaf extracts with chloroform. Virus yields reached 130 µg per 100 g of plant material. The $A_{260/280\ nm}$ ratio was 1.5. Infectivity, assayed by Bemisia tabaci fed through membranes, was associated with the occurrence of predominantly geminate particles (22 x 38 nm), which, however, were not completely separated form monomers, trimers, and tetramers. SLCV is circulative in B. tabaci with a relatively long latent period. A high frequency of transmission following the latent period is associated with apparent harmful effects of the virus on the vector. SLCV may multiply in the whiteflies. Serological studies demonstrated that SLCV is related to cassava latent virus, but not to four other geminiviruses.

DUFFUS, JAMES E. A new threat to the American sugar beet industry - Rhizomania. The Sugar Producer 10:28-29. 1984.

Rhizomania, one of the most destructive diseases of sugarbeet (Beta vulgaris L.) in Europe and Japan, was found in several of the important sugarbeet production areas of California in 1983. Rhizomania is reported to be caused by beet necrotic yellow vein virus (BNYVV), which is vectored by the soil fungus Polymyxa betae Keskin. The fungus was found in California in 1977 and the virus was found in Washington in 1981. Rhizomania was identified by the presence of BNYVV and P. betae in the roots of affected sugarbeet plants. BNYVV reacted in ELISA tests with antiserum to Japanese and French isolates of the virus, and characteristic virus particles were observed by electron microscopy of plant tissue dips.

DUFFUS, JAMES E. Predictive systems for plant viruses. Phytopathology 73:768. 1983.

Predictive systems are effective tools for the control of plant virus diseases. The basic techniques of phenological systems were developed over 50 years ago and have been used with a number of plant virus diseases with marked success. In general, the systems were based on simple virus-vector-plant disease relationships and involved late-warning procedures to control virus vectors. Although these simple control procedures have been successful in the past, there is little utilization of these methods in today's agriculture. The application of predictive systems to complex virus diseases involves virus-vector relationships, bionomics of vectors, migratory pathways, natural and crop virus reservoirs and plant virus interactions on several crop and weed species. The implementation will require a new enthusiasm and cooperation between traditional epidemiologists, virologists, entomologists, and mathematicians but should result in control of some of our most destructive diseases.

DUFFUS, JAMES E. Rhizomania. California Sugar Beet, pp 27-32. 1983.

DUFFUS, JAMES E. Whitefly vectors: virus-vector-plant interactions, transmission mechanisms and virus spread. Proc. Fourth International Congress of Plant Pathology Symposium 1:1. 1983.

An explosion of whiteflies in the southwest deserts of USA during 1981 was felt throughout the country and resulted in losses of over $100,000,000 to farmers and consumers. Populations of Bemisia tabaci reached unusually high levels resulting in great losses due to virus diseases in virtually every major crop grown in this desert region. These previously unknown losses in a relatively small agricultural area give new insight of the economic significance of whitefly induced diseases in the world. Known in all continents, except perhaps Antarctica, the whitefly transmitted agents produce a wide and divergent group of diseases most of which have not been characterized. The agents are transmitted by several whitefly species by nonpersistent, semi-persistent, persistent and even perhaps multiplicative mechanisms. The viruses thus far characterized form at least four separate virus groups, ranging from geminivirus particles (20-38 nm), short rods (660 nm), long flexuous rods (2000 nm) and isometric particles (30 nm). Studies on the epidemiology of the diseases and the biology of the vectors are urgently needed and may lead to effective control measures for these destructive disease systems.

DUFFUS, J. E., E. D. WHITNEY, R. C. LARSEN, H. Y. LIU, and R. T. LEWELLEN. First report in Western Hemisphere of Rhizomania of sugar beet caused by beet necrotic yellow vein virus. Plant Disease 68: (In press). 1984.

DUFFUS, J. E., E. D. WHITNEY, R. C. LARSEN, H. Y. LIU, and R. T. LEWELLEN. Rhizomania, a destructive new disease. Sugar Journal 46:26. 1983.

FALK, B. W. and J. E. DUFFUS. Identification of a small RNA associated with severe symptoms in beet western yellows virus infected Capsella bursa-pastoris. Phytopathology (In press). 1984.

Analysis of beet western yellows virus for nucleic acid content gave unexpected results. One isolate yielded two species of nucleic acid while other strains of BWYV and similar related viruses have only one nucleic acid. This isolate with the two nucleic acids is much more pathogenic than the other single nucleic acid isolates. This has important implications on the nature of luteoviruses and the possibilities of satellite RNA's.

HOEFERT, L. L. Ultrastructure of Cucurbita spp. infected with whitefly-transmitted squash leaf curl virus. Phytopathology 75:790. 1983.

Squash leaf curl is a whitefly-transmitted (Bemisia spp.) disorder that bears striking cytological similarities to bean golden mosaic (Kim, Shock, and Goodman, 1978, Virology 89:22-23), Euphorbia mosaic (Kim and Flores, 1979, Phytopathology 69:980-984), and other whitefly-transmitted diseases of the geminivirus type. Electron micrographs of vascular cells in infected leaves show nuclei with masses of small spherical particles (<20 nm) that

occur singly, in pairs, in groups, and in strands. Fibrillar rings appear in nuclei that may or may not contain viruslike particles. Vascular parenchyma cells show a unique type of cytoplasmic vesiculation that is not found in cells infected with other viruses of known vascular affinities. Nuclear changes occur in phloem, xylem, and border parenchyma cells. The disease provokes rapid phloem degeneration which may account for the rapid expression of external symptoms.

HOUK, M. S. and L. L. HOEFERT. Ultrastructure of Chenopodium leaves infected by lettuce infectious yellows virus. Phytopathology 75:790. 1983.

The newly discovered lettuce infectious yellows virus (LIYV) is a flexuous rod virus known to be transmitted by whiteflies (Bemisia spp.). Particles similar in size and shape to isolated LIYV (Duffus, et al. 1982. Phytopathology 72:963) are present in the vascular parenchyma and sieve elements from diseased leaves of infected Chenopodium plants. In parenchyma cells, bundles of viral particles are often associated with amorphous clumps of electron dense material and with clusters of vesicles which are often enclosed within a common membrane. The vesicles average 60 nm in diameter and are filled with a filamentous material. Several other inclusions prevalent in virus-infected material are also described. The ultrastructure of the virus and associated structures closely resembles published accounts of closteroviruses such as beet yellows virus and beet yellow stunt virus. LIYV is, however, unique because of its whitefly vector and its wide range of host plants (Duffus & Flock. 1982. Calif. Agric. 36:4).

JOHNSTONE, G. R., J. W. ASHBY, A. J. GIBBS, J. E. DUFFUS, G. THOTTAPPILLY, and J. D. FLETCHER. The host ranges, classification and identification of eight luteoviruses causing diseases in legumes. Neth. J. Plant Pathol. (In press). 1984.

A total of 71 seed lines representing 23 species of papilionoid legumes and 17 species of non-legumes were inoculated with eight luteoviruses isolated from legumes in Australia, New Zealand, the Netherlands, and the United States of America. The viruses were a beet western yellows (BWYV) strain from Glycine max, legume yellows (LYV), a yellowing isolate from Medicago sativa in Michigan (MiAV), leaf rolling isolates from Pisum sativum in New Zealand (PeLRV-NZ) and the Netherlands (PeLRV-N), isolates of subterranean clover red leaf from New Zealand (SCRLV-NZ) and Tasmania (SCRLV-T), and subterranean clover stunt (SCSV).

JOHNSTONE, G. R. and JAMES E. DUFFUS. Yellows of sugarbeet in Tasmania caused by a complex of subterranean clover red leaf and beet western yellows viruses. Aust. J. Agr. Res. (In press). 1984.

Beet western yellows virus (BWYV) and subterranean clover red leaf virus (SCRLV) were isolated from naturally infected sugarbeet plantings in Tasmania. Observations on weed and crop plants suggested the widespread occurrence of BWYV in Tasmania. Transmissions from plants showing typical BWY-like symptoms demonstrated that they were infected with persistent aphid-transmitted entities differing in symptom characteristics and host range. Limited host range tests indicate that BWYV isolates differ from each other

in host and symptom reaction but some react in a manner similar to American isolates, i.e. can infect both sugarbeet and lettuce. The results of these investigations show for the first time the widespread occurrence of BWYV in Tasmania but do not indicate the economic impact of the virus alone or in combination with other virus entities.

LARSEN, RICHARD C. and JAMES E. DUFFUS. A simplified procedure for the purification of curly top virus and the isolation of its monomer and dimer particles. Phytopathology 74:114-118. 1984.

Curly top virus was purified from shepherd's purse plants (Capsella bursa-pastoris) 4-5 wk after inoculation with viruliferous beet leafhoppers Circulifer tenellus). The virus-containing sap was clarified with chloroform, the virus precipitated and concentrated by polyethylene glycol, and subjected to two cycles of high-speed ultracentrifugation. Monomer and dimer particles were isolated from partially purified preparations by sucrose density gradients. Infectivity assays indicated that the dimer particle is required for infection. Virus yields obtained averaged 500 µg/kg of plant material. The $A_{260-280\ nm}$ ratio for dimers was ~1.4.

LEWELLEN, R. T. Breeding sugarbeet for crop efficiencies. Proc. Calif. Plant and Soil Conference 1984:165-168. 1984.

Recurrent selection methods may be used to improve breeding populations for hybrid performance. Within self-fertile sugarbeet, population improvement was not readily feasible until genetic male sterility was introduced to create male-sterile facilitated random mating. Within one such population, S_1 progeny recurrent selection was shown to be a highly effective breeding technique.

LEWELLEN, R. T. and I. O. SKOYEN. Beet western yellows can cause heavy losses in sugarbeet. Calif. Agric. 38:4-5. 1984.

Beet western yellows virus is a common disease agent in sugarbeet in the West. This paper reports the results of several years' studies on the effects of western yellows on sugarbeet performance. In susceptible breeding lines and cultivars, western yellows was found to induce losses of greater than 30%. Conversely, breeding lines from the yellows resistant breeding program were shown to have losses only up to 6-8%.

McFARLANE, J. S. Yellow wilt: A potential threat to the sugarbeet industry. The Sugar Journal 46:11-13. 1983.

The destructive yellow-wilt disease occurs only in Argentina and Chile, but could be introduced into other semi-arid areas including the western United States. Once established, the disease could potentially cause severe losses. Since 1963, cooperative research involving the United States and Chile has been underway to study the disease and to breed for resistance.

Under cool conditions, diseased plants are yellow and dwarfed with narrow leaves. When temperatures are high and humidity low, infected plants wilt and may die within a few days. The causal agent was first identified as a

virus, later as a mycoplasmalike organism (MLO), and most recently as a rickettsia like organism (RLO). The causal agent is transmitted by Paratanus exitiosus, a leaf hopper that is known to occur only in Argentina and Chile.

None of our present sugarbeet cultivars is resistant to the disease. Breeding work has been underway in Chile since 1967 to develop resistant breeding lines. A moderate level of resistance has been incorporated by making repeated selections within open-pollinated curly top-resistant cultivars. Resistance has also been discovered in an accession of B. maritima and in a Chilean wild beet. The cooperative breeding work will be terminated in 1984 and seeds of the moderately-resistant selections are being placed in the National Seed Storage Laboratory in Fort Collins, Colorado.

McFARLANE, J. S., HELEN SAVITSKY, and ARNOLD STEELE. Breeding for resistance to the sugarbeet nematode. J. Amer. Soc. Sugar Beet Technol. 21:311-323. 1982.

This study was initiated to select for resistance to the sugarbeet nematode and to evaluate these selections in the field. Over 88,000 plants were tested and several lines were developed that transmitted resistance to 100% of their offspring. In the field tests, nematode larvae invaded the roots of resistant plants, caused plant damage, but were unable to complete their development. Nematode populations were lower in soil adjacent to resistant plants. Cultivars resistant to nematode development may be of greatest value as a trap crop.

STEELE, A. E. and L. WHITEHAND. Comparative morphometrics of eggs and second stage juveniles of Heterodera schachtii and a race of H. trifolii parasitic on sugarbeet in The Netherlands. J. Nematology. (In press). 1984.

Measurements of second-stage juveniles of Heterodera schachtii from California and The Netherlands and a race of H. trifolii from The Netherlands were obtained and compared to determine if these populations can be differentiated on the basis of morphometrics. Juvenile lengths of ten specimen from each of ten cysts of each population were measured. Dimensions of tail regions of 20 juveniles from individual cysts of H. schachtii (California) and a like number of juveniles of H. trifolii (The Netherlands) were also obtained. The mean lengths of juveniles of H. schachtii from California and The Netherlands were not significantly different but similar measurements of H. schachtii and H. trifolii were ($P=0.05$). Mean dimensions of tail lengths, tail widths, tail hyaline lengths and tail length/tail width were significantly greater for H. trifolii than for H. schachtii. Also, dimensions of eggs of H. trifolii were significantly greater than dimensions of H. schachtii eggs. The investigations established that H. schachtii can be readily differentiated from H. trifolii by morphometrics of eggs and juveniles. Minimum sample sizes required for specified confidence intervals for each criterion measured are provided.

WHITNEY, E. D. and R. T. LEWELLEN. Registration of C35/1 and C35/2 sugarbeet germplasm. Crop Sci. (In press). 1984.

Because of the recent introduction of virulent isolates of Erysiphe polygoni into the United States few adapted cultivars of sugarbeet have resistance to powdery mildew. C35-1 and C35-2 are among the first cultivars to have resistance to E. polygoni and a number of other serious diseases of sugarbeet: virus yellows, curly top, Erwinia root rot, downy mildew and rust, as well as bolting resistance.

WHITNEY, E. D. and R. T. LEWELLEN. Registration of C40 sugarbeet germplasm. Crop Sci. (In press). 1984.

Erwinia carotovora betavasculorum is a recently discovered pathogen of sugarbeet which causes a root rot. Field testing for resistance and resistance breeding are essential to the development of resistant cultivars adapted to California and Arizona. C40 used as an estimator of environmental variation and as a top-cross tester will expedite the development of resistant cultivars.

YU, M. H. Meiosis in some nondiploid sugarbeets and distribution of chromosomes in their derivatives. Agron. Abstr. p. 86. 1983.

After the nucleoli disappeared, chromosomes in microsporocytes of monoploid sugarbeets are blob shaped and scattered irregularly throughout the cells. In addition to univalents, bivalents and secondary associations occurred at meta-anaphase I. These chromosomes usually do not form metaphase I plates. At anaphase I the majority of cells of monoploids (2n = 9) and autotriploids (2n = 27) chromosomes tended to migrate to the two poles forming nuclei of unequal sizes. Other cells generated laggards, or chromatid bridges, or both. Second meiosis is more irregular than the first, which results in micronuclei, restitution nuclei, and bridges. Aberrant number of cells from monads to polyads were formed at tetrad stage. Offspring from diploid pollinated monoploid sugarbeets contained chromosomes ranging from 9 to 36; whereas that of autotriploids had 18 to 38. Not a single aneuploid, between 10 and 17 chromosomes, was recovered which suggests that sugarbeet gametes with a complete set of 9 component chromosomes may not survive.

YU, M. H. Sugarbeet germplasm resistant to sugarbeet nematode. Crop Sci. 23: 1021-1022. 1983.

Sugarbeet germplasm line H770 has resistance to the sugarbeet cyst nematode. The mortality of nematode larvae in this line is very high and the mechanism of the resistance is antibiosis. This line is the pooled seed increased from S_2 progeny of the true breeding nematode-resistant diploid sugarbeet selection 3584, which originated as a self-fertile, multigerm, green hypocotyl plant derived from a hybrid between the annual, self-fertile C5600 and a diploid, biennial, self-sterile sugarbeet plant heterozygous for nematode resistance. In meiosis one intercalary and one terminal chromatid loop at the pachytene stage and up to two dicentric bridges at anaphase I or II occasionally occurred in the microsporocytes. It segregates for annual and biennial bolting characteristics. It will be of value as a nematode-resistant germplasm source for conducting sugarbeet nematode resistance research.

YU, M. H. and JONES, K. C. Preliminary biochemical assay on resistance to Heterodera schachtii in sugarbeet. Genetics 104:s73. 1983.

Resistance to the cyst nematode is lacking in the primary gene pool of sugarbeet. Notwithstanding, this resistance has been introgressed from a wild beet species into sugarbeet via interspecific hybridization. This dominant resistance factor(s) caused a high mortality of nematode juveniles feeding

on the resistant sugarbeet hosts. One possible explanation to the larvicidal activity is the presence of a toxic compound in syncytial areas of the roots. Both XAD-2-retained and non-retained fractions of MeOH extracts of the resistant sugarbeets showed activity in reducing larval migration through the Kimwipe barrier compared to the non-treated controls. The preliminary results also suggest that there may be two or more active compounds in the extract and that this activity cannot be exclusively distinguished as the result of the presence of aromatic or non-aromatic compounds. In general, nematicidal activity of the extracts and fractions was low and variable. Resistance in the resistant sugarbeet lines may in fact be due to the presence of a phytoalexin, a substance that formed subsequent to the nematode infection.

PAPERS WHICH HAVE BEEN PUBLISHED SINCE BEING ABSTRACTED IN PREVIOUS SUGARBEET RESEARCH REPORT

LIU, H. Y. and JAMES E. DUFFUS. The differentiation of distinct serotypes from potato leafroll affected plants by enzyme-linked immunosorbent assay (ELISA). Amer. Potato J. 59:476. 1982.

STEELE, A. E. Effects of selected nematicides on hatching of Heterodera schachtii. J. Nematol. 15:467-473. 1983.

STEELE, A. E., H. TOXOPEUS, and W. HEIJBROEK. Susceptibility of plant selections to Heterodera schachtii and a race of H. trifolii parasitic on sugarbeet in The Netherlands. J. Nematol. 15:281-288. 1983.

WHITNEY, E. D. and I. O. SKOYEN. Control of Rhizoctonia root rot of sugarbeet by fungigation with Terraclor. Fungic. Nematic. Tests 39:94. 1983.

YU, M. H. Interpretation of mechanism for nematode resistance in sugarbeet. J. Am. Soc. Sugar Beet Technol. 21:351-361. 1982.

INTERSPECIFIC HYBRIDIZATION

Cytogenetical Study of Monoploid Sugarbeet

M. H. Yu

Monoploids, or haploids, of higher plant species are sporophytes which have the gametophytic chromosome number. They thus represent a breakdown in the normal association of the diploid chromosome number with the sporophyte and the haploid number with the gametophyte. Usually, however, haploids are not the product of the elimination of the morphologically and physiologically distinct gametophyte from the life cycle since they arise by the parthenogenetic functioning of some component of the embryo sac.

Sugarbeet, Beta vulgaris L., is considered to be a stable diploid plant. Just like many other species of plants, however, there are many different ploidy levels of chromosome compositions existing in the B. vulgaris population. The more common types of the nondiploid genotypes are tetraploids, triploids and aneuploids. Monoploids in sugarbeet occur spontaneously, but only at a low rate. In addition to spontaneous origins, there are several other treatment procedures available to enhance the induction of monoploids, such as wide crossing, X- or gamma-ray irradiations, chemical treatments, and alien cytoplasm, etc.

Preliminary investigation on some 28,000 self-incompatible C17 sugarbeet seedlings showed that only 231, or 0.83%, were classified as nonhybrid products. Among these nonhybrid plants, four were identified to be monoploids, based on root tip chromosome examination. The remainder of plants were all diploids. Thus, only 1.73% of the nonhybrid plants, or 0.014% of all progeny (including hybrid and nonhybrid) plants, were monoploids. Bosemark induced monoploid sugarbeets in Sweden. He recovered monoploid plants from nonhybrid progeny at 1.62% (5/309) frequency. The rate of 1.62% was almost equal to the 1.73% in this study.

Chromosomal movements of monoploid sugarbeets at meiosis are very much different from that of diploid ones. At the early prophase stages, the meiotic chromosomes of monoploid sugarbeet have a similar appearance compared to that of diploids. After the nucleoli disappeared the univalents are usually scattered irregularly throughout the cell. They do not have well-defined arms. A striking difference in monoploid sugarbeet is that its meiotic chromosomes usually do not form a metaphase plate in the 1st division. Many cells show various frequencies of univalents, bivalents, and trivalents, and secondary associations among nonhomologous chromosomes at meta-anaphase I. Most of the bivalents are of the rod-type, and the trivalents are of the V-type. Bivalents occurred in more than 14% of cells, and trivalents occurred in more than 1% of cells. From these results an average of 8 univalents, 0.4 bivalents, and 0.08 trivalents, or 0.63 chiasmata per cell was calculated for monoploid plant M220. And an average of 8.7 univalents, 0.2 bivalents, and 0.01 trivalents, or 0.22 chiasmata per cell was estimated for plant M116.

The occurrence of bivalents, trivalents, and secondary associations among nonhomologous chromosomes at metaphase I is a significant event in terms of phylogenetic evolution of Beta species. These phenomena indicate the possible presence of genetically similar or duplicated segments in otherwise nonhomologous chromosomes of this monoploid sugarbeet plant. If there is no partial homology among normally nonhomologous chromosomes, all chromosomes will appear as univalents at metaphase I. The occurrence of more than three secondary associations, formation of up to three bivalents, and coexistence of bivalents and trivalents in single pollen mother cells indicates the possible presence of three or more different sets of genetical duplications in the basic genome of sugarbeet which involved at least six of the nine component chromosomes.

Because the equatorial plates usually do not form at metaphase I, spindle fibers are consequently unnoticeable. Even though there was a lack of such metaphase I orientation, most of univalents, nevertheless, migrated to the poles and sorted themselves into unequal groups in all possible combinations, ranging from 5 - 4 chromosomes to 9 - 0. The 5 - 4 distribution of chromosomes was the most frequent type at anaphase I.

If there is no preferential assortment of the univalents to the poles, each will randomly migrate to either pole according to a binomial distribution $(a + b)^n$. The results of this study showed a highly significant divergence (based on chi-square tests) in the chromosome distribution, largely due to an excess of the 8-1 and 7-2 distributions. The occurrence of various types of chromosomal associations presumably caused some deviations from the binomial distribution.

Many cells contained laggards. The number of laggards ranged from one to six. Occasionally one or more chromosomes underwent misdivision. The destiny of the misdivided chromosomes was uncertain, but they generally moved toward the opposite poles. Several anaphase I cells in the monoploid sugarbeets formed dicentric chromatid bridges or bridge-like structures with and without acentric fragments. Some of the anaphase I bridges were not broken even after telophase, but persisted into the second meiotic division. At the end of telophase I various numbers and sizes of nuclei, including restitution nuclei which contained all the nine chromosomes formed.

The occurrence of more than one bridge and fragments at the first division provides additional evidence for the existence of duplication of genetic material in the single genome of sugarbeet. If an exchange between two nonhomologous chromosomes takes place within homologous segments possessing the reverse gene order in the two synapsed arms, one bridge and one fragment can result. Such configurations have been reported in monoploid maize and barley. Bridges unaccompanied by fragments can arise from a similar exchange in homologous segments with the same serial gene order with respect to the centromere or from chromosomal stickiness that does not involve breakage and reunion. The noticeable frequency of meiotic cells containing single bridge as well as two separate bridges were definitely not accidental. They were likely resulted from exchanges that took place between different pairs of nonhomologous chromosomes.

Dicentric bridges and acentric fragments have been observed in progeny from crosses of diploid sugarbeets with a common ancestry. However, synapsis and recombination in diploids are probably different from that in monoploids because two homologues are present. Duplicated segments in nonhomologous chromosomes cannot be expected to pair frequently, particularly if such segments are short.

At second prophase, distribution of the nine chromosomes and nucleoli may be traced. Metaphase II chromosomes appeared to be more normally oriented than those at first division. Chromosome movement at second anaphase and telophase was, however, frequently more irregular than that at first meiosis. It resulted in producing laggards and spindle abnormalities of various types. Both anaphase II bridges and the carry-over anaphase I bridges were observed. Consequently, many different sizes and numbers of sporads, from one to five, were present as the end products of the meiosis.

When the four available monoploid sugarbeets were pollinated by diploid sugarbeets, three monoploid plants set seed, but the fourth plant did not yield any. From these three monoploid parents more than 200 progeny seedlings were obtained. The distribution of chromosome numbers in their progeny ranged from monoploid to tetraploid levels. From monoploid parents, only one type of aneuploid plant, having 19 chromosomes, was found. Approximately 92% of progeny were diploids. Although other higher ploidy levels of plants, such as triploids and tetraploids, were found, not a single aneuploid plant with chromosome number in between 10 and 17 was recovered. This suggests that sugarbeet gametes without a complete set of nine component chromosomes may not survive.

DEVELOPMENT OF BREEDING LINES AND GERMPLASM
SUMMARY OF TRIALS, 1983

R. T. Lewellen and I. O. Skoyen

RHIZOMANIA--For several years, root symptoms similar to those of rhizomania had been observed in late planted (April-May) trials at Salinas. See page A23, 1982 Report. In 1977, Duffus had identified Polymyxa betae in the Salinas Valley. In 1981, sugarbeet plants with bearded roots from Salinas tests were examined in Whitney's lab by Ms. Mann and L. Kovacev, a visiting scientist from Yugoslavia, and cystosori identical to those of P. betae were observed. In July of 1983 when symptoms characteristic of BNYVV were observed on scattered sugarbeet leaves in a late April planted observation trial, it was of no great surprise. Within weeks of observing BNYVV foliar symptoms and incipient bearding of the roots, Larsen and others in Duffus' lab had identified the virus as BNYVV (by local lesion assay and EM). Subsequently, using ELISA techniques, Duffus' lab positively identified the virus as BNYVV.

Within a few months of announcing this inauspicious find, rhizomania-like symptoms were observed near Paso Robles, Tracy, Antelope Valley, South San Joaquin Valley, Mendota, Los Banos, Dixon, Davis, etc. and P. betae and BNYVV were later positively identified. Primarily these finds were located in fields that were planted in late spring under warm soil conditions. Because of an unusually wet winter and spring, soils were wetter than usual and cultural practices less than optimum. After touring these fields with sugar company fieldmen, it was obvious that rhizomania can have a devastating effect upon yield. Also, the general consensus was reached that the disease must have been present in California for many years to be so widely dispersed and that a combination of environmental factors favorable to the disease increased its apparent severity. Many knowledgeable fieldmen and growers also felt that it was not a new problem (just newly recognized) and that the "bearded" root condition had been mistakenly attributed to nematodes, herbicides, hard pans, other root disorders, etc. Whatever the history, it is certain that a new research and production problem faces the sugarbeet workers to understand and control this severe malady.

VIRUS YELLOWS, ERWINIA ROOT ROT, AND POWDERY MILDEW RESISTANCE BREEDING--Individual plant selection was again used to improve the disease resistance, adaptation, and performance of a wide range of sugarbeet multigerm and monogerm germplasm. A combined selection against BWYV, ERR, and PM was made in 36 breeding lines. Potentially severe and uniform levels of ERR were established and a moderately severe level of natural infection to PM should have permitted significant improvements in resistance. Mother roots selected in November will be increased in 1984. Emphasis was again placed upon selecting disease resistant roots with higher sucrose concentration. Germplasm lines with favorable combinations of traits will be released in 1984. In two observation tests, 288 entries were evaluated for their reaction to ERR and PM. These results are summarized in Test 2183. Tests to evaluate resistance to virus yellows were not completed for the first time in RTL's tenure at Salinas. Tests designed for this purpose were damaged by seedling disorders and loss of stands and split-block inoculations with virus yellows were not made. R. T. Lewellen and I. O. Skoyen.

S_1 PROGENY RECURRENT SELECTION--Tests in 1982 showed that S_1 progeny recurrent selection (RS) was effective at improving population performance for sugar yield (SY) through two cycles of selection (1982 Report, pages A39-41). However, it was not determined whether S_1 progeny RS also changed these populations for hybrid performance or combining ability for SY. In 1982, the C0, C1 and C2 synthetics were topcrossed to a common tester, C46. The genetic ms (a_1a_1) segregates of the synthetics were used as females to produce these experimental hybrids. In 1983, these variety hybrids and the original C0, C1, and C2 synthetics were tested for performance in the field at Salinas (Tests 183-1 and 183-2). Also included was a C2 synthetic that had been derived by one cycle of S_1 progeny selection and then by an additional cycle of mass selection for sugar yield under virus yellows conditions.

The results of Tests 183-1 and 183-2 are quite different. Under the more productive conditions of the January planted test (183-1), the hybrid performance of the four synthetics was not different and there was only an 8% increase in the C2 synthetic per se over the unselected check. The greatest change in the synthetics was for the synthetic derived by S_1 and mass selection. This may have been due to the occurrence of BWYV infection in Test 183-1. Test 183-1 showed considerable less response to selection than had been measured in the 1982 tests of the same material.

However, in the less productive environment of a later planting date and poorer soil conditions, Test 183-2 showed significant differences among entries for sugar yield. Most of these differences were for root yield. The results of this test for the synthetics per se are nearly the same as those obtained in 1982 tests. Based upon Test 183-2, S_1 progeny RS was effective at improving the synthetics per se and also their combining ability for SY. For the synthetics per se, the relative change in performance for SY for the C0, C1, C2, and C2 (S_1 + mass sel.) was 0.0, 13.8, 26.1, and 17.6%, respectively. For the hybrids produced from these synthetics, the relative change in SY performance was 0.0, 9.6, 19.5, and 15.6%, respectively. Even though SY (root yield x % S) was used as the selection criterion, the improved performance was primarily for root yield with relatively little change in % sucrose.
R. T. Lewellen and I. O. Skoyen.

EVALUATION OF S_1 FAMILIES--In a continuing program to evaluate the efficacy of S_1 family performance and S_1 progeny recurrent selection, 96 S_1 families were evaluated for performance in an incomplete block design in 1983. These S_1 families were randomly derived from the second cycle synthetic selected for sugar yield in monogerm, self-fertile population 790. That is, this is the progeny evaluation phase for the third cycle of selection and selected families from these progenies will be recombined to produce the third cycle synthetics. The field performance of these 96 S_1 progenies is summarized on the following page.

Although genetic variances were not calculated (Estimates of genetic variances and predicted responses to S1 family selection are biased, Bradshaw, J. E. 1983. Heredity 51:415-418), it appeared that a large amount of genetic variability still exists within this source for population improvement for all measured traits. On the basis of field observations and harvest data, we continue to be impressed by the much greater magnitude of variability

expressed among S_1 progenies than by other types of progeny families, e.g., HS or TX progenies. Even if S_1 progeny selection did not lead to improved combining ability, it would be a desirable way to develop lines for use in hybrids where line vigor and seed yield are important traits.

Means and ranges for 96 S_1 families from the second cycle of population 790D.

Planted: 5 May, 1983 Harvested: 2 December, 1983

Variable	Mean	Range	LSD (.05)	CV (%)
Sugar yield (lbs/A)	7,280	4,330 - 9,420	1,690	14.4
Root yield (t/A)	23.05	13.26 - 29.62	5.13	13.8
% Sucrose	15.83	14.47 - 17.57	1.17	4.6
Root rot (%)1/	0.5	0.0 - 3.4	3.3	298.3
Powdery mildew2/	3.2	0.0 - 9.0	2.7	53.5
Visual score3/	3.0	1.7 - 4.7	0.9	18.7
Root shape4/	3.0	1.0 - 5.0	1.3	26.0
Seedling rating5/	2.6	1.0 - 5.0	1.5	35.8
Beets/100 ft.	111	56 - 143	24.7	13.7

1/ Roots at harvest with soft rot (Erwinia).

2/ PM rated 0 = resistant to 9 = susceptible.

3/ Top vigor, canopy shape, color, uniformity, etc., where 1 = favorable to 5 = very unfavorable.

4/ Shape at harvest where 1 = single taproot to 5 = severely fanged or bearded.

5/ Seedling survival, vigor, early growth, etc. where 1 = good to 6 = very poor.

Some of the observed differences in performance were probably due to variability for reaction to diseases and soil conditions. However, powdery mildew infection was very late and no association occurred between the PM rating and yield. Little virus yellows infection was evident. A root condition similar to rhizomania (but BNYVV was not detected by ELISA) occurred in which seedlings died or lost their taproot and subsequent lateral roots causing a fangy or bearded appearance in some lines. The usual seedling pathogens could not consistently be identified. In a followup greenhouse test, seedlings established from seed of S_1 lines planted in unsterilized field soil reacted in a similar manner as in the field; lines rated as susceptible damped-off whereas those rated as resistant did not. There were no differences in sterilized soil. Early plant growth in the field was extremely slow and thinning was delayed. Later, plant development and growth was more nearly normal. R. T. Lewellen and I. O. Skoyen.

GCA OF RANDOMLY DERIVED INBRED LINES--Self-fertile (S^f), monogerm, near-T-O, random-mating populations have been developed at Salinas as a germplasm base for improving disease resistance, adaptation, bolting resistance, etc. of sources that are destined to be used to produce seed bearing parents of commercial hybrids. These male-sterile (a_1a_1) facilitated populations are

readily amenable to all types of population improvement including mass selection and various types of progeny evaluation and selection. There is a question, however, how to extract and identify inbred lines from these improved sources that are fixed and possess factors for high productivity in hybrid combinations. Methods based upon early generation progeny testing are being evaluated and appear to have merit. But these methods require 3-4 years per cycle and require large investments in breeding and program resources. A much more rapid and less expensive technique to extract advanced inbred lines would be to use a modified single-seed descent (SSD) technique. Rather than starting with an F_2 as is the common practice for SSD in autogamous crops, the source of the S_0 plants would be from one of the advancing cycles of a self-fertile, random-mating population with sufficiently high levels of productivity and disease resistance.

To determine if SSD could be used to discriminate the GCA differences in a source population, 90 S_0 plants were randomly selected from a synthetic of population 790 following one cycle of S_1 progeny selection for sugar yield and recombination. These S_0 plants were selfed and crossed to an annual T-O tester. From an overwintered S_1 progeny plot, stecklings from 74 lines identified as being T-O were harvested and the one best plant on the basis of root, foliar, and seed traits was chosen from each line and selfed in the greenhouse. This plant selection and selfing procedure was repeated through the S_3. Of the original 74 S_1 plants, 66 S_3 lines were produced that traced back to different S_0 plants. There were 8 lines that could not be easily reproduced because of low vigor or very poor seed traits. Three to four stecklings from the 66 S_3 lines were crossed in the greenhouse to 3-4 plants of the highly uniform C779CMS inbred. The following season, the F_1 CMS hybrids from these crosses were topcrossed to C46 in a field isolation plot. Of the 64 attempted topcrosses, all but two were successful. An average of 14 F_1 CMS plants of each line participated to produce 300-500 grams of seed for field testing. Two F_1 CMS lines were discarded due to partially fertility restoration. Plants within the individual F_1 CMS hybrids were very uniform at full flowering stage, but considerable variability occurred for plant and seed types among the F_1 hybrids.

The topcrossed experimental hybrids were grown in a field test at Salinas in 1983. A 64 entry x 8 replication RCB design was used in which there were 60 experimental hybrids [(C779CMS x 790-S_3) x C46] and four checks. Performance comparisons were made against the corresponding check hybrid [(C779CMS x 790 popn) x C46].

The S_3 lines derived from 790 by modified SSD represented only 25% of the parentage in the 3-way experimental hybrids. Even so, there was a significant difference in the performance of the experimental hybrids with a range in means from 20, 21, and 8% for sugar yield, root yield, and % S. Compared to the check hybrid, there were also SSD-S_3 lines that produced experimental hybrids with significantly better sugar and root yield than that of their source population. Under the conditions of this test, all except one of the C779CMS x 790-SSD-S_3 F_1 hybrids performed better than the standard commercial F_1, C562CMS x C546, for sugar yield. This corresponds to the results from Test 883 in which C2-790Daa x C46 was significantly better than (C562CMS x C546) x C46 for sugar yield.

Test 1083. Evaluation of GCA of 790-SSD-S_3 lines[1/]

64 entries x 8 reps
1-row plots, 29 ft long

Planted: April 8 (Reps 1-4); May 4 (Reps 5-8)
Harvested: Oct. 4 (Reps 1-4); Oct. 20 (Reps 5-8)

Entry				Acre Yield			Root
				Sugar	Beets	Sucrose	Rot
CMS	T-O		♂	lbs	tons	%	%
(C779CMS	x 790 popn)	x	C46	100	100	100	100
(C779CMS	x 790-SSD-S_3)	x	C46	94-114[2/]	93-114	95-103	0-390
Checks							
C779CMS		x	C46	105	108	97	103
790 popn CMS[3/]		x	C46	107	105	101	0
(C562CMS x C546)		x	C46	94	93	101	0
Mean (Actual)				9,014	29.52	15.54	0.4
LSD (.05) in %				9.6	9.3	3.7	NS
C. V. (%)				9.8	9.5	3.7	310
F value				1.6**	2.4**	1.9**	1.1NS

1/ Comparisons in % of check, (C779CMS x 790 popn) x C46.

2/ Range of 60 entries.

3/ 790 popn CMS is the near-equivalent of 790 following two cycles of S_1-progeny recurrent selection for sugar yield.

The experimental hybrids will be reevaluated in tests in 1984. But based upon this one year's data, randomly derived lines from one self-fertile, random-mating population did appear to be an effective and economical means of isolating genotypes (inbred lines) with both better and poor GCA than that for the population. R. T. Lewellen and I. O. Skoyen.

S_1-TX PROGENY EVALUATION--Selected S_1 lines from population 755 that were topcrossed (S_1-TX) and evaluated in progeny tests in 1980 and 1981 were retested in 1983. These tests are summarized in Tests 1583 and B183. Also see Test 1982, pages A34-35, 1982 Report. Included in these retests were the S_1-TX's of lines C301 through C307 that were recently released. In addition, on the basis of these retests, several additional lines increased from the original 755 S_1 lines may be released, e.g., increases of 755-43, 755-18, 755-34, 755-129, 755-16, and 755-46, that combine favorable disease resistance, type-O, and monogerm traits with improved sucrose content.

From the lines extracted from population 755, line C301 was the first to be released, increased, and extensively tested. C301 is an increase of the S_1 family, 755-29. In Tests 1583, B183, and others, the testcross with the original S_1 (755-29 x C37) was compared to later testcrosses with C301 (C301 x C37). In all of these comparisons, the C301 hybrids always had substantially better performance than the original 755-29 x C37 hybrid. To determine if this is a general phenomenon, tests will be made in 1984 to

compare the performance of the original and subsequent testcross hybrids with C302 through C307. These contrasts should provide additional insights into the usefulness and accuracy of S_1 or early generation testing for discriminating combining ability.

In 1983, three additional early generation progeny tests for GCA were made (Tests 1183, 1283, and 1383). These tests involved S_1 progenies from an improved 755 source and from populations 757 and 742 topcrossed to C46. As in previous early generation tests, there was considerable evidence for genetic differences in GCA within these sources. The best of the S_1-TX progenies will be reevaluated in field and disease trials in 1984 and a few apparently superior S_1 lines will be increased in greenhouse isolation chambers. Also, selected S_1 families will be recombined to produce improved synthetics. R. T. Lewellen and I. O. Skoyen.

PERFORMANCE OF RECIPROCAL POPULATION HYBRIDS--Reciprocal recurrent selection (RRS) in self-incompatible sugarbeet has been difficult due to the problems of making controlled crosses and saving selfed seed of the S_0 genotypes. Male-sterile facilitated random-mating populations could be easily manipulated to overcome these technical problems. In addition to self-fertile, random-mating populations which have been used for several years to improve monogerm sources, we are currently converting several of our disease resistant, MM, O.P. sources to nearly equivalent S^f, genetic ms facilitated random-mating populations. With these diverse monogerm and multigerm sources, it will be feasible to critically test RRS to simultaneously improve hybrid performance of both potential seed bearing and pollinator sources. However, before embarking on such a long term and expensive program, it was of interest to develop initial sources with high levels of disease resistance (CT, VY, NB, ERR, etc.) and near commercial usefulness. Also, because the monogerm sources would be used to test the multigerm sources and vice versa, it was of interest to determine how the equivalent reciprocal population hybrids would compare for performance. Although probably not the MM population that would be used for a RRS study, 747, a S^f, random-mating population similar to C36 and C37 was developed as an intermediate line and was used to produce reciprocal population hybrids with several S^f, mm sources. A summary of test results from 1983 follows on next page.

Based upon these and other comparisons for performance and ranking, it appears that these populations could be used as reciprocal testers to potentially improve the GCA of the populations and lines extracted from them, and that the performance of the hybrids or progeny families produced from them would not be dependent upon the direction of the cross. Several multigerm, S^f, random-mating sources are nearing the stage of development for disease resistance, nonbolting tendency, and hybrid performance that would justify their use in a long term empirical RRS study.
R. T. Lewellen and I. O. Skoyen.

Performance of Reciprocal Population Hybrids

Hybrid	Description[1/]	Acre Yield		Sucrose
		Sugar	Beets	
		lbs	tons	%
From Test B383				
2747H54	1755aa x 1747	9,248a	31.44a	14.72a
2755H53	1747aa x 1755	8,961a	30.29a	14.78a
From Test 483				
US H11		14,875a	46.78a	15.93a
2747H54	1755aa x 1747	15,677a	49.15a	15.97a
2755H53	1747aa x 1755	15,512a	48.01a	16.17a
From Test 1783				
2747H56	1757aa x 1747	9,208a	29.91a	15.49a
2757H53	1747aa x 1757	9,239a	29.52a	15.69a

1/ 1747 = S^f, MM, A:aa popn. 1755 and 1757 = S^f, mm, A:aa popns.

FIELD VARIETY TRIALS, SALINAS, CALIFORNIA, 1982-83

Location: USDA-ARS Agricultural Research Station

Soil type: Sandy loam (Chualar series)

Previous crops: 1982-83 Sugarbeet test areas, Spence Field:
Block 3 - 16.5A fallow 1980-82; sugarbeet trials 1979.

Fertilizer and pesticides used: Preplant: Dolomite (equivalent to 105% $CaCO_3$) was broadcast at rates of 800 lbs/A and disced in about 6" deep and 400 lbs. 5:20:10 was broadcast and chiseled in. Prior to seeding, about 330 lbs/A ammonium sulfate was Bye Hoe incorporated into a 9-inch band into the beds.

Supplemental nitrogen: One to three applications, as sidedressed ammonium sulfate or by sprinkler irrigation system as 32% nitrogen in a liquid formulation.

Total fertilization (lbs/A):

	N[1/]	P_2O_5	K_2O
Block 3	160-260	80	40

1/ Depending on seeding date.

Summary: 1983 Tests at Salinas (Spence Field):

Test No.	Sowing Date 1982-1983	Thinning Date 1983	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1983	Test Design
183-1	1/13	3/10	8	8	2	29	10/14	SP[1/]
183-2	4/7	5/10	8	8	2	29	10/31	SP[1/]
283-1	1/13	3/9	8	8	2	29	10/12	RCB
283-2	4/7	5/10	8	8	2	29	Abandoned	RCB
383-1	1/14	3/9	8	8	2	29	9/29-10/3	RCB
383-2	4/7	5/10	8	8	2	29	10/7	RCB
483	1/14	3/9	16	8	2	29	10/11-12	RCB
583	1/14	3/8	16	8	2	29	9/28-29	RCB
683	1/14	3/8	16	8	2	29	9/27-28	RCB
783	4/7	5/11	16	8	2	29	10/18-19	RCB
883	4/8	5/11	16	8	2	29	10/19-20	RCB
983	4/7	5/11	16	8	1	29	10/13	RCB
1083-1	4/8	5/12	64	4	1	29	10/3-4	RCB[3/]
1083-2	5/4	7/1	64	4	1	29	10/21-22	RCB[3/]
1183	4/8	5/12	64	4	1	29	10/4-6	RCB[2/]
1283	4/7	5/10	40	4	1	29	10/6	RCB[2/]
1383	5/4	6/30	48	4	1	29	11/1	RCB[2/]
1483	4/8	5/13	24	6	2	25	11/2-3	RCB[4/]
1583	5/4	6/30	32	8	1	29	10/24-25	RCB
1683	5/5	6/30	16	8	1	61	10/25-26	RCB
1783	5/5	7/1	16	8	1	61	10/26-27	RCB

Test No.	Sowing Date 1982-1983	Thinning Date 1983	Test Entries No.	Reps No.	Plot Row No.	Plot Row Lgth. Ft.	Harvest Date 1983	Test Design
1883	5/5	6/30	8	8	1	61	10/27	RCB
2083	5/5	7/1	96	3	1	25	12/2	RCB2/
2183-1	4/26	6/15	288	2	1	15	--	--5/
2183-2	5/20	6/27	288	1	1	27	--	--6/

1/ Split plot
2/ Incomplete blocks
3/ Incomplete blocks, location 1 (Reps I-IV), location 2 (Reps V-VIII).
4/ Fuel-fodder beet test.
5/ PM-ERR Obs. Test-Research Station.
6/ PM-ERR Obs. Test-Spence Field.

Irrigation: By either furrow or sprinkler system as required at 7-14 day intervals except during stand establishment when frequent light sprinkler irrigations were used.

Herbicide use: Nortron at an average rate of 0.74 gal/A and Pyramin W, at an average rate of 3.9 lbs/A, were sprayed post plant and watered in with 1/2 to 3/4 inch sprinkler irrigation.

Diseases and insects: Natural virus yellows infection was moderate and probably mainly BWYV in January seeded tests and appeared light in April and May seeded tests. Insect infestations were minor throughout season. A mild earwig infestation along the north edge of the January seedings was controlled with 2% Sevin bait.

Powdery mildew infection was moderately severe in 1983 where it was not controlled and appeared first (mid-June) in the earliest seeded tests. The degree of control, with applications of Bayleton, was good. Spray applications of Bayleton, depending on appearance of PM, at rates of about 6-8 oz./A were made on June 23 and August 10, 1983.

Downy mildew infection was nil in 1983.

Natural infection of Erwinia soft rot was light in susceptible lines and had minimum effect on yield in 1983.

Sugarbeet nematode was not observed in 1983 test areas.

Rhizomania and/or unidentified seedling blights were severe in April and May seeded tests and caused severe yield reductions in yield tests. Polymyxa betae was identified in some affected plants. Also, ELISA tests confirmed the presence of Beet Necrotic Yellow Vein Virus (BNYVV) in a few root samples.

Sugar analysis: Determined from two samples per plot of approximately 10 roots each or 25-40 lbs. of roots at the sugar analytical laboratory, U.S. Agricultural Research Station, Salinas, California.

Remarks: Only the January seeded tests had high reliability in 1983. The April and May seeded tests suffered heavy seedling losses shortly after emergence and many surviving plants showed effects of injury and grew poorly throughout the season.

The assistance of Dr. F. J. Hills and Patricia Thomas, University of California at Davis, in the analysis of test data is gratefully acknowledged.

PURITY ANALYSES OF FROZEN BREI AND FILTRATE--From Tests 583 and 683, frozen brei was shipped to the American Crystal Research Center for purity analyses. From Test 783 and 883, frozen filtrate was sent for analyses. The American Crystal lab analyzed these samples for pol, Na, K, NH_2-N, NO_3-N, and conductivity. The statistical analyses of these tests were not completed in time to be included in the 1983 Report. When completed, these data will be provided, including pertinent correlations between the analyses based on fresh brei at Salinas and on frozen brei or filtrate at Moorhead.

TEST 483. HYBRID EVALUATION OF GENETIC MALE-STERILE POPULATIONS, SALINAS, CA, 1983

16 entries x 8 reps, RCB
2-row plots, 29 ft. long

Planted: January 14, 1983
Harvested: October 11-12, 1983

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity	Extract. Sugar
		Lbs	Tons	%	%	%	Number	%	%	Lbs/T
Y246H54	1755aa x Y146	16,559	48.72	17.00	1.9	0.0	125	2.33	88.0	299
Y246H60	1759aa x Y146	16,469	50.21	16.46	0.9	0.0	120	2.16	88.4	291
E137HL2	0755aa x F80-37	16,382	50.13	16.36	0.2	0.3	130	2.24	88.0	287
Y246H56	1757aa x Y146	16,105	47.48	16.98	0.5	0.2	121	2.40	87.6	297
Y246H64	1216aa x Y146	15,929	47.73	16.76	0.5	0.0	125	2.38	87.5	293
Y246H61	1755-29aa x Y146	15,875	47.72	16.64	0.9	0.2	121	2.27	88.0	292
2747H56	1757aa x 1747	15,845	49.12	16.17	7.4	0.0	131	2.36	87.3	282
E137HL6	0755-29aa x F80-37	15,803	48.56	16.28	0.5	0.0	122	2.38	87.3	284
Y231H53	1747aa x Y131	15,785	47.83	16.54	1.0	0.0	127	2.43	87.2	288
2747H54	1755aa x 1747	15,677	49.15	15.97	2.4	0.2	130	2.28	87.5	279
2755H53	1747aa x 1755	15,512	48.01	16.17	2.0	0.0	121	2.38	87.2	281
Y246H63	1214aa x Y146	15,316	45.77	16.75	0.2	0.2	126	2.32	87.8	294
2797H53	1747aa x 0792-8	15,255	47.34	16.16	0.0	0.2	123	2.53	86.4	279
Y246H8	F78-546H3 x Y146	15,055	45.34	16.64	0.4	0.0	128	2.40	87.4	290
2747H62	1206-13aa x 1747	14,966	46.22	16.18	3.3	0.2	114	2.51	86.6	280
US H11	546H3 x C36 (282110)	14,875	46.78	15.93	0.2	0.0	130	1.98	89.0	283
Mean		15,713	47.88	16.44	1.4	0.09	125	2.33	87.6	287
LSD (.05)		973	2.47	0.63	1.3	NS	8	0.20	0.9	12
C. V. (%)		6.3	5.2	3.89	96.1	401.40	7	8.8	1.1	4
F value		2.3**	2.6**	2.2*	15.7**	0.8NS	2.3**	3.6**	3.9**	2.4**

1/ Y146 = C46; Y131 - C31E2. 0755-29 = C301. 546H3 = C562CMS x C546. 1755, 0755, 1757, 1759, 1216, 1214, 0792-8, 1206-13 are S^f, A:aa, mm, near T-O populations that are being improved for disease resistance (VY, CT, ERR, PM, ...). 1747 = S^f, A:aa, M- population similar to C37 for disease resistance. Entries 2747H54 and 2755H53 are reciprocal hybrids. 1747 and similar advanced populations are being developed to test reciprocal recurrent selection with various types of progeny families.

Note: A low to moderate level of BWYV occurred. PM was controlled with Bayleton and sulfur.

TEST 583. EVALUATION OF HYBRID PERFORMANCE OF O.P. GERMPLASM, SALINAS, CA, 1983

16 entries x 8 reps, RCB
2-row plots, 29 ft. long

Planted: January 14, 1983
Harvested: September 28-29, 1983

Variety	Description[1/]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolting %	Root Rot %	Beets/ 100' Number	Non Sucrose SS %	Raw J. App. Purity %	Extract. Sugar Lbs/T
Y231H33	1546H72 x Y131	15,605	48.24	16.18	0.7	0.5	135	2.88	84.9	274
Y246H33	1546H72 x Y146	15,227	47.04	16.18	0.0	0.0	137	2.84	85.1	275
2747H8	F78-546H3 x 1747	15,160	47.49	15.98	1.6	0.0	138	2.87	84.8	271
Y231H8	F78-546H3 x Y131	15,158	45.57	16.64	1.0	0.2	135	2.94	85.0	282
HH37	Holly Hybrid	15,096	45.85	16.46	4.4	0.4	132	2.86	85.2	280
E137H8	546H3 x F80-37	14,983	46.18	16.23	0.5	0.0	132	2.81	85.3	276
Y246H9	0546H3 x Y146	14,977	45.17	16.59	0.0	0.0	135	2.79	85.6	284
E137HL29	0546H72 x F80-37	14,956	47.47	15.79	0.3	0.0	136	2.68	85.5	270
U236H6	(C566H0 x C546) x C36	14,778	46.83	15.79	0.5	0.0	136	2.92	84.4	266
Y141H8	F78-546H3 x Y041	14,746	45.41	16.27	1.2	0.1	142	2.94	84.8	275
Y246H8	F78-546H3 x Y146	14,641	44.35	16.52	0.0	0.2	132	3.02	84.6	279
Y254H8	F78-546H3 x 1201-5	14,521	44.35	16.41	0.6	0.3	130	2.84	85.2	279
Y152H8	F78-546H3 x Y052	14,363	44.06	16.27	0.6	0.3	140	2.94	84.8	275
US H11	546H3 x C36 (282110)	14,262	44.83	15.94	1.0	0.0	138	2.84	84.9	270
Y149H8	F78-546H3 x Y049	14,082	45.36	15.53	0.5	0.2	135	2.68	85.4	265
SS-Z1	Spreckels Hybrid	13,410	39.66	16.94	0.2	0.5	136	2.93	85.3	289
Mean		14,748	45.49	16.23	0.8	0.2	136	2.86	85.0	276
LSD (.05)		908	1.65	0.71	1.1	NS	NS	NS	NS	13
C. V. (%)		6.2	3.7	4.4	135.5	291.7	6	9.0	1.2	5
F value		2.7**	11.4**	2.1*	7.3**	1.2NS	0.9NS	1.1NS	0.9NS	2.1*

1/ Y131 = C31E2, Y146 = C46, F80-37 = C37. 546H3 = C562CMS x C546, 0546H72 and 1546H72 = C718CMS x C546.

Note: A low to moderate level of BWYV occurred. PM was controlled with Bayleton and sulfur.

TEST 683. HYBRID PERFORMANCE OF MONOGERM AND MULTIGERM GERMPLASM, SALINAS, CA, 1983

16 entries x 8 reps, RCB
2-row plots, 29 ft. long

Planted: January 14, 1983
Harvested: September 26-27, 1983

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity	Extract. Sugar
		Lbs	Tons	%	%	%	Number	%	%	Lbs/T
Y231H16	0755HO x Y131	15,140	47.08	16.09	0.9	0.3	137	3.13	83.8	269
Y246H15	1755-29HO x Y146	14,974	46.60	16.06	2.8	0.0	123	3.01	84.2	270
Y254H16	0755HO x 1201-5	14,915	48.76	15.30	0.6	0.0	136	2.92	84.0	257
Y246H21	1755-29H72 x Y146	14,879	47.43	15.69	0.3	0.2	131	3.15	83.3	261
Ultramono	Maribo	14,800	41.03	18.05	2.0	0.5	133	3.27	84.7	305
Y246H42	1546HL5 x Y146	14,790	46.22	15.99	0.3	0.3	136	3.10	83.8	267
Y231H19	1796HO x Y131	14,767	47.05	15.70	1.0	0.0	125	3.04	83.8	263
2747H16	0755HO x 1747	14,638	48.03	15.24	2.4	0.0	141	3.01	83.4	254
Y246H41	1546HL3 x Y146	14,535	44.53	16.33	0.3	0.0	127	3.11	84.0	274
Y246H72	9718HO x Y146	14,525	45.81	15.87	0.0	0.8	130	2.92	84.5	268
E137HL5	0755-29HO x F80-37	14,450	46.64	15.48	0.9	0.2	129	3.06	83.5	258
E137H8	546H3 x F80-37	14,285	46.13	15.51	0.7	0.0	133	2.92	84.2	261
US H11	546H3 x C36 (282110)	14,083	45.85	15.41	1.0	0.2	138	2.99	83.8	258
Y246H16	0755HO x Y146	14,079	45.41	15.49	0.7	0.5	129	3.10	83.3	258
Y246H3	8562HO x Y146	14,021	43.34	16.18	0.2	0.0	126	3.08	84.0	271
Y246H8	F78-546H3 x Y146	13,927	43.65	15.96	0.0	0.0	127	3.16	83.5	266
Mean		14,550	45.85	15.90	0.9	0.2	131	3.06	83.9	266
LSD (.05)		NS	1.72	0.86	1.0	0.4	8	NS	NS	15
C. V. (%)		7.0	3.8	5.4	120.0	243.8	6	9.60	1.3	6
F value		1.1NS	10.0**	4.7**	5.0**	2.4**	3.3**	0.9NS	1.3NS	5.1**

1/ F80-37 = C37, Y146 = C46, Y131 = C31E2. 546H3 = C562CMS x C546, 1546HL5 = C301CMS x C546, 0 and 1755-29HO = C301CMS, 1755-29H72 = C718CMS x C301, 1546HL3 = 0755CMS x C546. 0755 = CMS phase of S^f, A:aa, mm population, 1796HO = CMS phase of S^f, A:aa, mm population. 8562HO = C562CMS, 9718HO = C718CMS.

Note: A low to moderate level of BWYV occurred. PM was controlled with Bayleton and sulfur. A doubled rate of Nortron-Pyramin was accidentally applied which caused considerable seedling distortion but did not appear to differentially influence performance.

TEST 783. HYBRID PERFORMANCE OF BREEDING LINES, SALINAS, CA, 1983

16 entries x 8 reps, RCB
2-row plots, 29 ft. long

Planted: April 7, 1983
Harvested: October 18-19, 1983

Variety	Description[1/]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' Number	Non Sucrose SS %	Raw J. App. Purity %	Extract. Sugar Lbs/T
E137HL5	0755-29H0 x F80-37	9,869	33.28	14.84	0.2	129	2.14	87.4	259
E137HL29	0546H72 x F80-37	9,814	32.58	15.06	0.2	128	2.23	87.1	262
BJ19	Bush-Johnson's	9,773	30.00	16.31	1.5	130	2.29	87.7	286
Y246H21	1755-29H72 x Y146	9,574	31.63	15.14	0.6	114	2.33	86.7	262
Y246H15	1755-29H0 x Y146	9,378	31.45	14.98	0.8	117	2.21	87.2	261
Y246H42	1546HL5 x Y146	9,308	31.09	15.01	0.2	118	2.36	86.4	259
Y246H16	0755H0 x Y146	9,214	30.39	15.20	0.6	126	2.36	86.6	263
Y246H41	1546HL3 x Y146	9,203	30.01	15.32	0.2	122	2.29	87.0	266
Y246H72	9718H0 x Y146	9,115	30.25	15.11	0.0	107	2.31	86.7	262
E137H8	546H3 x F80-37	8,952	30.30	14.78	0.0	125	2.18	87.2	257
Y246H33	1546H72 x Y146	8,904	29.70	15.01	0.2	117	2.16	87.5	262
US H11	546H3 x C36 (2110)	8,884	29.26	15.20	0.0	129	2.28	87.0	264
Y246H3	8562H0 x Y146	8,782	28.25	15.54	0.6	116	2.34	86.9	270
Y246H8	F78-546H3 x Y146	8,673	27.65	15.68	0.2	111	2.45	86.5	271
HH37	Holly	8,503	27.59	15.46	0.5	120	2.22	87.5	270
SS-Z1	Spreckels	8,142	25.98	15.71	1.1	116	2.44	86.6	272
Mean		9,131	29.96	15.27	0.4	120	2.29	87.0	265
LSD (.05)		563	1.77	0.46	0.8	11	NS	NS	9
C. V. (%)		6.2	6.0	3.1	195.3	9	9.3	1.2	3
F value		5.9**	9.2**	5.7**	2.2*	3.1**	1.6NS	1.1NS	4.7**

1/ F80-37 = C37, Y146 = C46. 545H3 = C562CMS x C546. 0546H72 and 1546H72 = C718CMS x C546, 1755-29H72 = C718H0 x C301, 1546HL5 = C301CMS x C546, 1546HL5 = C755CMS x C546. 0755-29H0 and 1755-29H0 = C301CMS, 9718H0 = C718H0, 8562H0 = C562CMS.

Note: An unidentified root problem (symptoms similar to rhizomania but plants negative for BNYVV) caused some early damping-off and plant loss and severe sprangling in older plants. Severity of infection with BWYV and PM was low.

TEST 883. HYBRID PERFORMANCE OF MONOGERM GERMPLASM, SALINAS, CA, 1983

16 entries x 8 reps, RCB
2-row plots, 29 ft. long

Planted: April 8, 1983
Harvested: October 19-20, 1983

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot	Beets/ 100'	Non Sucrose SS	Raw J. App. Purity	Extract. Sugar
		Lbs	Tons	%	%	Number	%	%	Lbs/T
Y246H61	1755-29aa x Y146	10,687	35.32	15.18	0.0	127	2.38	86.4	262
Y246H21	1755-29H72 x Y146	10,652	36.50	14.60	0.2	123	2.10	87.4	255
E137HL6	0755-29aa x F80-37	10,505	35.82	14.67	0.0	129	2.21	86.9	255
Y246H54	1755aa x Y146	10,430	34.67	15.08	0.0	130	2.21	87.2	263
Y246H64	1216aa x Y146	10,378	33.80	15.41	0.0	125	2.37	86.7	267
Y246H56	1757aa x Y146	10,345	33.37	15.51	0.0	112	2.37	86.8	269
E137HL2	0755aa x F80-37	10,326	34.73	14.90	0.0	137	2.23	87.0	259
E137H8	546H3 x F80-37	10,219	34.60	14.78	0.3	136	2.19	87.1	257
Y246H68	1790Daa x Y146	10,124	32.65	15.48	0.3	126	2.43	86.4	267
Y231H19	1796H0 x Y131	10,106	34.09	14.86	0.2	129	2.27	86.7	257
US H11	563H3 x C36 (2110)	9,986	34.14	14.60	0.3	137	2.11	87.4	255
Y254H8	F78-546H3 x 1201-5	9,851	33.37	14.83	0.0	125	2.22	87.0	258
Y231H8	F78-546H3 x Y131	9,674	32.81	14.65	1.4	132	2.16	87.2	255
Ultramono	Maribo	9,655	29.60	16.31	1.9	129	2.17	88.3	288
Y246H8	F78-546H3 x Y146	9,539	31.17	15.32	0.2	120	2.28	87.1	266
Y246H58	0742aa x Y146	9,452	30.86	15.34	0.3	122	2.36	86.7	265
Mean		10,121	33.59	15.10	0.3	127	2.25	87.0	262
LSD (.05)		621	3.43	0.58	0.8	9	0.20	NS	11
C. V. (%)		6.20	10.3	3.9	255.7	7	9.1	1.2	4
F value		3.1 **	2.3**	5.0**	3.5**	3.9**	2.0*	1.5NS	4.4**

1/ Y146 = C46, F80-37 = C37, Y131 = C31E2. 755-29 = C301. 1755, 1757, 1790, 1796, 1216, and 0742 = S^f, A:aa, near-T-O, mm populations improved for disease resistance.

Note: See note for Test 783. However, plant loss and sprangling were less severe. Severity of BWYV and PM was low.

TEST 983. EVALUATION OF HYBRID PERFORMANCE OF MONOGERM POPULATIONS, SALINAS, CA, 1983

16 entries x 8 reps, RCB
1-row plots, 29 ft. long

Planted: April 7, 1983
Harvested: October 13, 1983

Variety	Description[1/]	Acre Yield[2/] Sugar Lbs	Acre Yield[2/] Beets Tons	Sucrose %	Root Rot %	Beets/ 100' Number	Miss. Feet Row Ft.
Y246H15	C301CMS x C46	9,911	33.25	14.89	0.0	116	1.0
Y246H43	(755CMS x 546) x C46	9,542	31.40	15.23	0.0	110	0.9
Y246H41	(757CMS x 546) x C46	9,287	30.77	15.11	0.3	121	0.4
Y246H34	(740CMS x 546) x C46	8,979	29.41	15.28	0.7	120	0.9
Y246H33	(C718CMS x 546) x C46	8,890	29.44	15.16	0.0	117	1.4
Y246H39	(790CMS x 546) x C46	8,840	29.12	15.20	0.0	115	0.5
US H11	(C562CMS x C546) x C36	8,672	29.28	14.84	0.0	122	0.4
Y246H42	(C301CMS x 546) x C46	8,638	29.46	14.74	0.8	115	1.3
Y246H36	(742CMS x 546) x C46	8,593	28.06	15.34	0.5	116	0.8
Y246H38	(745CMS x 546) x C46	8,565	28.50	15.09	0.5	118	1.3
Y246H37	(744CMS x 546) x C46	8,525	27.66	15.42	0.0	117	0.9
Y246H40	(790DCMS x 546) x C46	8,454	27.70	15.25	0.3	112	1.5
Y246H9	(C562CMS x 546) x C46	8,369	27.71	15.14	0.0	109	2.0
Y246H6	(C566CMS x C546) x C46	8,357	27.69	15.12	0.4	106	0.9
Y246H35	(741CMS x C546) x C46	8,350	26.83	15.63	0.0	116	2.0
Y246H8	(C562CMS x C546) x C46	8,257	27.46	15.04	0.0	106	2.3
Mean		8,765	28.98	15.15	0.2	115	1.1
LSD (.05)		674	2.63	NS	NS	NS	NS
C. V. (%)		8	9.10	9.0	417.8	10.5	120.5
F value		5.9**	3.3**	0.3NS	0.8NS	1.2NS	1.4NS

1/ CMS phase of mm, near-TO, S^f, A:aa populations were crossed to 546 and then topcrossed to C46. 546 = C546 reselected for ERR and % S.

2/ Test has fair reliability. Plot emerged to a complete stand but by thinning stage, many plants were being lost or severely damaged by a seedling disease. The usual seedling pathogens (Pythium, Aphanomyces, Rhizoctonia, etc.) were not isolated. At harvest about half of roots were normal for size and shape. The other half were sprangled, misshapen and bearded. Most bearded roots did not have vascular necrosis and were negative for BNYVV, but in ELISA tests by Dr. Liu, 5 out of 8 roots with severe bearding and vascular necrosis were positive for BNYVV (Rhizomania). Plot was variable for severity of sprangling and/or bearding. The bearding suggested a high incidence of fungal damage (Polymyxa betae?) but a low level of virus (BNYVV).

TEST 1683. PERFORMANCE EVALUATION OF HYBRIDS, SALINAS, CA, 1983

16 entries x 8 reps, RCB[1]/
1-row plots, 61 ft. long

Planted: May 5, 1983
Harvested: October 25-26, 1983

Variety	Description[4]/	Acre Yield[2]/ Sugar Adj.	Beets Adj.	Sucrose	Root Rot	Beets/ 100'	Miss. Feet Row	Non Sucrose SS	Raw J. App. Purity	Sugar Yd. Not Adj.[3]/
		Lbs	Tons	%	%	Number	Ft	%	%	Lbs/A
Y246H15	755-29H0 x Y146	10,600	33.24	15.98	0.2	80	8.9	2.64	85.8	9,073
E137HL45-16	755-16aa x F80-37	10,565	33.16	15.95	0.2	85	4.8	2.78	85.2	9,804
Y231H16	755H0 x Y131	10,071	30.28	16.69	0.7	84	6.4	2.79	85.7	9,013
E137HL45-26	755-26aa x F80-37	9,965	29.83	16.72	0.4	71	10.4	2.91	85.2	8,307
E037HL16-119	755-119aa x C37	9,953	30.30	16.46	0.0	62	16.0	2.83	85.3	7,328
HH37	Holly	9,876	28.88	17.13	0.2	82	6.1	2.84	85.8	8,900
Y246H42	546HL5 x Y146	9,854	30.19	16.34	0.3	77	8.4	2.81	85.3	8,515
Ultramono	Maribo	9,852	26.82	18.38	2.3	90	6.1	2.94	86.2	8,863
Y246H54	755aa x Y146	9,770	28.99	16.88	0.5	68	12.5	2.80	85.8	7,788
E137HL6	755-29aa x F80-37	9,675	31.15	15.60	0.0	72	8.8	2.80	84.8	8,294
Y246H21	755-29H72 x Y146	9,594	29.90	16.07	0.3	69	12.3	2.78	85.3	7,685
E137HL29	546H72 x F80-37	9,568	30.10	15.88	0.0	80	8.5	2.65	85.7	8,254
Y246H8	546H3 x Y146	9,245	27.92	16.60	0.0	67	12.8	2.98	84.8	7,331
E137H8	546H3 x F80-37	8,885	27.90	15.94	0.3	89	5.0	2.76	85.2	8,140
S101H	Spreckels	8,797	28.58	15.39	1.7	46	22.6	3.02	83.5	5,552
US H11	546H3 x C36 (2210)	8,512	27.20	15.67	0.0	85	6.5	2.79	84.9	7,604
Mean		9,674	29.65	16.35	0.5	76	9.7	2.82	85.3	8,153
LSD (.05)		706	2.44	0.70	1.2	12	4.9	NS	NS	1092
C. V. (%)		7.4	8.30	4.30	259.3	16	51.0	10.60	1.8	13
F value		5.3**	4.5**	8.6**	2.6**	6.4**	7.2**	1.0NS	1.3NS	6.3**

1/ Tests 1683, 1783, and 1883 were designed as split-blocks to evaluate reaction to virus yellows. Because of stand problems, virus treatments were not made and the tests were harvested as RCB's. An unidentified seeding problem caused differential plant loss after seedling emergence. Problem may have been caused by a pathogenic agent, herbicide, or their interaction. After thinning, plants and roots grew normally.

2/ Beet yield and sugar yield adjusted for missing feet of row.

3/ Sugar yield not adjusted for missing feet.

4/ Y146 = C46, F80-37 = C37, Y131 = C31E2. 755-29 = C301, 755-16, 755-26, and 755-119 = S_1 lines from 755 population. 546H3 = C562CMS and C546, 546HL5 = C301CMS x C546, 755-29H72 = C718CMS x C301, and 546H72 = C718CMS x C546.

TEST 1783. PERFORMANCE EVALUATION OF O.P. AND MULTIGERM GERMPLASM, SALINAS, CA, 1983

16 entries x 8 reps, RCB[1]/
1-row plots, 61 ft. long

Planted: May 5, 1983
Harvested: October 26-27, 1983

Variety	Description[4]/	Acre Yield[2]/ Sugar Adj. Lbs	Acre Yield[2]/ Beets Adj. Tons	Sucrose %	Root Rot %	Beets/ 100' Number	Miss. Feet Row Ft	Non Sucrose SS %	Raw J. App. Purity %	Sugar Yd. Not Adj.[3]/ Lbs/A
Y254H53	747aa x 1201-5	9,446	29.86	15.88	0.0	86	5.3	2.54	86.2	8,598
Y246H58	742aa x Y146	9,440	29.03	16.26	0.3	76	9.5	2.84	85.1	7,941
Y254	Inc. 1201-5	9,394	28.46	16.57	0.3	81	5.5	2.66	86.1	8,555
Y231	Inc. Y131 (C31/4)	9,320	28.44	16.43	0.5	91	3.5	2.70	85.9	8,803
2757H53	747aa x 757	9,239	29.52	15.69	0.3	72	10.1	2.77	85.0	7,755
2747H56	757aa x 747	9,208	29.91	15.49	0.2	90	3.6	2.50	86.1	8,675
Y246H53	747aa x Y146	9,156	27.95	16.38	0.0	84	7.3	2.52	86.7	8,056
F82-46	Inc. C46 (82459)	9,129	27.16	16.82	0.0	80	8.0	2.71	86.1	7,905
Y249	YR-ER Y049	8,869	27.08	16.40	0.0	87	4.6	2.62	86.2	8,201
2747	747aa x A	8,810	27.85	15.83	0.0	89	6.0	2.54	86.2	7,955
Y252	YR-ER Y052	8,689	26.37	16.49	0.2	82	5.4	2.77	85.6	7,901
968	Inc. 468 (US 75)	8,338	27.89	14.94	0.2	86	5.0	2.83	84.1	7,677
SP6822-0	Lot 6519	8,053	25.04	16.06	0.3	78	6.3	2.54	86.3	7,229
2757	757aa x A	7,663	23.79	16.10	0.0	47	22.4	3.08	84.0	4,859
F82-36	Inc. C36 (82421)	7,560	25.22	15.00	0.0	69	10.5	2.78	84.3	6,312
F81-37	Inc. C37 (81101)	7,203	22.46	16.04	0.0	90	5.3	2.84	85.0	6,580
Mean		8,720	27.25	16.02	0.1	81	7.4	2.70	85.6	7,688
LSD (.05)		734	2.66	0.73	NS	11	4.4	0.26	1.4	904
C. V. (%)		8.5	9.80	4.60	367.4	13	60.3	9.80	1.6	11
F value		7.9**	5.3**	4.3**	0.7NS	7.6**	8.3**	2.8**	3.3**	10.1**

1/ See footnote for Test 1683. Virus yellows and PM infection was low.

2/ Beet yield and sugar yield adjusted for missing feet of row.

3/ Sugar yield not adjusted for missing feet.

4/ Y146 = C46, Y049 and Y052 = MM, O.P., 1201-5 = composite cross of O.P., MM, YR lines. 747 = M-, S^f, A:aa populations. 2757H53 and 2747H56 are reciprocal population hybrids.

TEST 1583. RETEST[1/] OF E037HL16 AND E137HL45 S_1-TESTCROSS PROGENIES, SALINAS, CA, 1983

32 entries x 8 reps, RCB
1-row plots, 29 ft. long

Planted: May 4, 1983
Harvested: October 24-25, 1983

Variety	Description[2/]	Acre Yield		Sucrose	Beets/ 100'	Miss. Feet Row	Non Sucrose SS	Raw J. App. Purity	Extract. Sugar
		Sugar Lbs	Beets Tons	%	Number	Ft	%	%	Lbs/T
E137HL45-16	0755-16aa x C37	7,720	23.15	16.73	131	0.6	2.69	86.1	288
E037HL16-125	9755-125aa x C37	7,587	23.11	16.44	113	1.6	2.50	86.8	285
E137HL45-46	0755-46aa x C37	7,493	20.76	18.03	141	0.4	3.05	85.5	308
E037HL16-35	9755-35aa x C37	7,488	22.39	16.78	120	1.0	2.54	86.9	291
E137HL6	C301 x C37	7,476	22.33	16.73	122	0.8	2.74	85.9	287
E037HL16-18	9755-18aa x C37	7,476	21.63	17.35	118	1.1	2.59	87.0	301
E037HL15	9755aa x C37	7,354	21.22	17.41	126	0.8	2.68	86.7	301
E137HL45-53	0755-53aa x C37	7,324	21.69	16.93	134	0.5	2.69	86.3	292
E137HL45-30	0755-30aa x C37	7,256	22.29	16.31	125	0.6	2.37	87.4	285
E037HL16-133	9755-133aa x C37	7,232	20.74	17.49	122	1.8	2.70	86.6	303
E137HL45-70	0755-70aa x C37	7,190	20.99	17.17	124	0.6	2.72	86.3	296
E137HL2	0755aa x C37	7,113	21.05	16.98	125	0.3	2.61	86.7	294

1/ In 1980, S_1 families from 8755 population were topcrossed to C37. In 1981, S_1 families from 9755 were topcrossed to C37. On the basis of progeny tests in 1981 and 1982, selected S_1-TX were reevaluated in this test. The results of this test may have low reliability. Considerable root problems occurred which resulted in damping-off, differential plant loss, sprangling, bearded roots, and extremely poor root and top growth. Although not positively identified in this test, rhizomania (BNYVV) was serologically found in an adjacent test. Yields are adjusted for missing feet of row.

2/ Checks = US H11, 546H3 x C37, C718H0 x C37, and C563H0 x C37. C301, 2, 3, 4, 5, 6, and 7 were increased from 9755-29, -27, -35, -52, -82, -110, and -119, respectively. 0755-16 ranked third in the 1982 progeny test for sugar yield, lines 0755-46 and 0755-22 ranked first and second for % sucrose. Lines 0755-16, -26, -51, and -70 were increased and will be identified as lines 3811, 3812, 3813, and 3814.

TEST 1583. RETEST[1/] OF E037HL16 AND E137HL45 S_1-TESTCROSS PROGENIES, SALINAS, CA, 1983 (Cont'd.)

32 entries x 8 reps, RCB
1-row plots, 29 ft. long

Planted: May 4, 1983
Harvested: October 24-25, 1983

Variety	Description	Acre Yield Sugar	Acre Yield Beets	Sucrose	Beets/ 100'	Miss. Feet Row	Non Sucrose SS	Raw J. App. Purity	Extract. Sugar
		Lbs	Tons	%	Number	Ft	%	%	Lbs/T
E137H72	C718H0 X C37	7,048	21.44	16.57	131	0.5	2.42	87.3	289
E037HL16-119	9755-119aa x C37	6,976	20.38	17.23	97	4.8	2.72	86.4	297
E137HL45-51	0755-51aa x C37	6,976	20.35	17.16	125	1.1	2.84	85.8	294
E137H8	546H3 x C37	6,966	20.98	16.69	138	0.5	2.85	85.5	285
E037HL16-110	9755-110aa x C37	6,964	20.70	16.88	115	1.8	2.54	86.9	293
E137H4	C563H0 x C37	6,956	21.11	16.49	135	0.4	2.50	86.9	286
E037HL16-29	9755-29aa x C37	6,913	20.80	16.63	98	0.9	2.73	85.9	285
E037HL16-112	9755-112aa x C37	6,912	20.13	17.24	116	0.9	2.77	86.2	297
E037HL16-34	9755-34aa x C37	6,846	19.72	17.41	113	1.8	2.55	87.2	303
E037HL16-27	9755-27aa x C37	6,801	19.70	17.36	101	2.1	2.83	86.0	298
E137HL45-87	0755-87aa x C37	6,734	19.44	17.31	122	0.9	2.81	86.1	297
US H11	546H3 x C36	6,670	19.89	16.84	128	0.9	2.59	86.7	291
E037HL16-10	9755-10aa x C37	6,653	19.88	16.80	114	1.9	2.95	85.1	285
E037HL16-82	9755-82aa x C37	6,607	19.25	17.21	113	1.8	2.54	87.2	300
E137HL45-26	0755-26aa x C37	6,607	19.21	17.21	110	1.8	2.74	86.3	296
E037HL16-43	9755-43aa x C37	6,423	18.47	17.43	102	3.8	2.81	86.1	300
E037HL16-129	9755-129aa x C37	6,305	17.81	17.72	75	6.5	2.88	86.1	304
E037HL16-52	9755-52aa x C37	6,256	18.14	17.29	117	0.9	3.08	85.0	293
E137HL45-22	0755-22aa x C37	6,206	17.42	17.81	96	3.5	3.34	84.2	300
E037HL16-77	9755-77aa x C37	5,880	17.05	17.29	101	3.3	3.11	84.8	293
Mean		6,950	20.41	17.09	117	1.6	2.73	86.2	294
LSD (.05)		968	3.07	0.54	14	1.9	0.29	1.3	11
C. V. (%)		14	15.20	3.20	13	117.2	10.80	1.5	4
F value		1.6**	2.0**	4.5**	7.4**	4.3**	4.2**	2.8**	2.8**

TEST 183-2. PERFORMANCE AND GCA OF CO:C1:C2 SYNTHETICS OF POPULATION 790, SALINAS, CA, 1983

8 entries x 8 reps, split plot[1]/
2-row plots, 29 ft. long

Planted: April 7, 1983
Harvested: October 31, 1983

Variety[2]/	Description[3]/	Acre Yield: Sugar Actual	Sugar Change[4]/	Beets Actual	Beets Change	Sucrose Actual	Sucrose Change	Root Rot	Beets/ 100'
		Lbs	%	Tons	%	%	%	%	Number
Y246H68	C2(SY by S_1 eval.)aa x C46	9,553	19.6	28.85	17.2	16.54	1.3	0.2	122
Y246H69	C2(SY by S_1 + MS)aa x C46	9,360	16.2	28.11	13.0	16.63	1.9	0.0	118
Y246H67	C1(SY by S_1 eval.)aa x C46	8,990	9.6	27.42	9.0	16.40	0.5	0.4	115
Y246H66	CO (Check) aa x C46	8,443	0.0	25.83	0.0	16.32	0.0	0.6	114
1790D	C2(SY by S_1 eval.)aa x A	7,156	26.1	21.95	25.1	16.31	0.7	0.4	118
2790	C2(SY by S_1 + MS)aa x A	6,674	17.6	20.46	16.6	16.32	0.9	0.4	117
7790D	C1(SY by S_1 eval.)aa x A	6,459	13.8	20.54	17.1	15.68	-3.1	0.2	108
7790C	CO (Check) aa x A	5,676	0.0	17.55	0.0	16.19	0.0	0.2	104
Mean		7,789		23.84		16.30		0.3	115
LSD (.05)		727	9.3	2.09	8.8	0.49	3.0	NS	9
C. V. (%)		9.3		8.70		3.00		240.9	8
F value for varieties		33.4**		33.2		2.8*		0.5NS	3.3**
F value for popns. vs. hybrids		140.5**		97.2**		8.4*		0.0NS	4.2NS
F value for varieties x trtmts.		0.2NS		0.5NS		1.1NS		0.9NS	0.7NS

Note: Virus yellows and powdery mildew were mild. A seedling root rot, damping-off problem occurred that reduced initial stands and caused root sprangling. Some roots resembled rhizomania, but BNYVV could not be identified. Overall, this test appeared to have good reliability.

1/ Main plots were synthetics vs. their corresponding hybrids. Subplots were CO, C1, and C2 generations.

2/ Corresponding synthetics and hybrids are: Check - 7790C and Y246H66; C1 for SY by S_1 eval. - 7790D and Y246H67; C2 for SY by S_1 eval. - 1790D and Y246H68; C2 for SY by S_1 eval. in C1 and mass selection (MS) in C2 - 2790 and Y246H69.

3/ See pages A39-41 and footnote 1, page A39 for a description of how these synthetics were derived.

4/ Synthetic CO (7790C) was used as a check within the synthetics and CO x C46 (Y246H66) within the hybrids to calculate percent change.

TEST 183-1. PERFORMANCE AND GCA OF CO:C1:C2 SYNTHETICS OF POPULATION 790, SALINAS, CA, 1983

8 entries x 8 reps, split plot[1]
2-row plots, 29 ft. long

Planted: January 13, 1983
Harvested: October 14, 1983

Variety[2]	Description[3]	Acre Yield: Sugar Actual	Sugar Change[4]	Beets Actual	Beets Change	Sucrose Actual	Sucrose Change	Bolters	Root Rot	Beets/ 100'
		Lbs	%	Tons	%	%	%	%	%	Number
Y246H68	C2(SY by S_1 eval.)aa x C46	14,472	2.7	44.95	4.9	16.11	-1.8	0.5	0.2	122
Y246H66	CO (Check) aa x C46	14,178	0.0	43.34	0.0	16.41	0.0	0.0	0.2	122
Y246H69	C2(SY by S_1 + MS)aa x C46	14,167	-0.1	43.73	1.2	16.21	-1.2	0.4	0.0	123
Y246H67	C1(SY by S_1 eval.)aa x C46	13,745	-4.0	43.29	-0.2	15.85	-3.4	1.3	0.0	118
2790	C2(SY by S_1 + MS)aa x A	12,671	16.9	37.85	15.2	16.73	1.4	4.0	0.2	127
1790D	C2(SY by S_1 eval.)aa x A	11,742	8.4	36.26	10.4	16.17	-2.0	2.5	0.0	127
7790D	C1(SY by S_1 eval.)aa x A	11,092	2.4	35.59	8.3	15.51	-6.0	5.1	0.3	129
7790C	CO (Check) aa x A	10,835	0.0	32.86	0.0	16.50	0.0	8.8	0.4	122
Mean		12,863		39.73		16.19		2.8	0.2	124
LSD (.05)		1,272	9.9	3.13	7.9	0.73	4.5	2.2	NS	NS
C. V. (%)		9.8		7.80		4.50		78.5	290.0	6.7
F value for varieties		10.9**		17.5**		2.2*		14.9**	0.8NS	1.5NS
F value for popns. vs. hybrids		44.9**		117.4**		0.1NS		75.0**	1.9NS	1.1NS
F value for varieties x trtmts.		1.6NS		1.5NS		1.4NS		7.0**	0.9NS	3.2NS

Note: BWYV infection was moderate, PM was controlled with Bayleton and sulfur. Other diseases or adversities appeared to be minor.

1/, 2/, 3/, and 4/. See footnotes for test 183-2.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1982-83

Location: USDA-ARS, Imperial Valley Conservation Research Center

Soil type: Holtville silty clay loam

Previous crops: 1982 and 1981 cereals; 1980 sugarbeet

Fertilization: Preplant with 200 lbs/A 46:0:0 and 180 lbs/A 11:48:0

Summary: 1982-83 Tests, Brawley, California

Test No.	Seeding Date 1982[1]	Entries per Test	No. Reps.	Rows per Plot	Plot Length Ft.	1983 Harvest Date	Test Design
B183	9/8	16	8[2]	1	24	5/17	RCB
B283	"	8	8	2	"	5/17-18	"
B383	"	8	8	2	"	5/18	"
B483	"	16	8	2	"	3/	"
B583	"	16	8	2	"	3/	"
B683	9/9	16	8	2	"	5/19-20	"

1/ Watered by sprinkler 9/9-11/83.
2/ No. reps harvested: B183 (6), B283 (5), B383 (6).
3/ Not harvested due to poor stands.

Irrigations: Sprinkled as needed to establish stands. Then furrow irrigated on 10/27, 11/25, 1/17, 3/1, 3/24, 4/20.

Thinning: September 27-28, 1982.

Herbicide: 3 pts/A Eptam 7E through irrigation water.

Diseases and insects: 9/19, 10/7, and 10/22, Lannate (0.7 lbs/A), Lannate (0.8 lbs/A), and Thuricide (0.5 lbs/A) with Lorsban (1 pt/A) for control of fleabeetles, fleabeetles and loopers, and armyworms. 3/17/83 sulfur (40 lbs/A) to control powdery mildew. Powdery mildew was still evident at harvest. Bolting was very light. Very little root rot occurred, but rot present appeared to be due to Erwinia. Virus yellows was evident at a high incidence (100% infection). Probably both BWYV and LlY occurred. VY appeared to be more severe in these plots than in commercial fields. Although the types of viruses were not differentiated, some plants with similar symptoms as observed in 1982 were noted; i.e., punky roots with proliferation of lateral roots, high tare, and dark vascular rings. Empoasca were causing leaf yellowing at time of harvest.

Harvest and sugar analyses: Plots were dug with Holly's spike wheeled lifter and sugar analyses made by Holly's tare lab. Two samples per plot were run.

Remarks: At emergence, many plants were lost due to insect damage and volunteer grain. These problems were severe enough to prevent tests B483 and B583 from being harvested for yield. For tests B183, 283, and 383, only 6, 5, and 6 reps were harvested and these tests probably had only fair reliability. Test B683 was excellent and reliability should be very good. Yields were probably influenced by a moderate incidence of virus yellows (BWYV and LIY).

We wish to acknowledge J. Robertson and C. Brown for plot supervision and cultural practices.

TEST B683. IMPERIAL VALLEY TEST, BRAWLEY, CA, 1982-83

Analysis of frozen brei for purity[1/]

Variable	Variety		
	US H11	HH37	Y246H8
% Sucrose (fresh)	15.42	16.35	16.09
% Sucrose (frozen)	15.45	16.23	15.83
Gross Sugar/A (lbs)	8,522	9,727	9,219
Ext. Sugar/A (lbs)	7,083	8,360	7,718
Ext. Sugar/T (lbs)	257	279	265
% Extract. Sugar	83.1	85.9	83.7
Na ppm on beet	173	198	213
K ppm on beet	2,318	2,200	2,500
NH_2-N ppm on beet	1,150	960	1,100
Impurity value	17,326	15,316	17,445
Impurity index	1,121	944	1,102
KSL/A	1,439	1,367	1,501
NO_3-N rating (fresh)	1.9	1.4	1.4
NO_3-N rating (frozen)	29.9	23.7	31.1
Conductivity grade	45.9	43.9	47.9
% S. conductivity	2.4	2.1	2.4

1/ From test B683, brei from all sugar samples was saved and frozen. However, only the 16 samples for these three varieties were shipped to American Crystal for analyses of purity. Despite problems in quickly freezing the brei in the Imperial Valley and partial thawing in transit to Salinas, the data appear valid.

TEST B683. IMPERIAL VALLEY SEMI-COMMERCIAL AND COMPANY HYBRID TEST, BRAWLEY, CALIFORNIA, 1982-83

16 entries x 8 replications, RCB
2-row plots, 24 ft. long

Planted: September 9, 1982
Harvested: May 19-20, 1983

Variety	Description	Acre Yield[1/] Sugar Lbs	Acre Yield[1/] Beets Tons	Sucrose %	Bolting %	Root Rot %	Beets/ 100' Number	Clean Beets %	Nitrate Nitrogen Rating
73303-014	Holly	10,692	33.21	16.11	0.7	0.2	134	95.3	1.6
E137HL4	0755aa x F80-37	10,610	32.43	16.37	0.3	0.1	155	94.0	1.6
Y246H21	(C718H0 x C301) x Y146	9,897	31.59	15.66	0.0	0.0	145	93.6	1.7
HH37	Holly	9,727	29.75	16.35	0.5	0.0	159	95.6	1.4
H79254	Spreckels	9,702	29.59	16.46	0.0	0.0	169	94.8	2.0
Y246H8	F78-546H3 x Y146	9,219	28.68	16.09	0.0	0.2	154	93.0	1.4
2C0105	Betaseed	9,202	28.89	15.95	1.1	0.2	123	91.8	1.8
1459-02	Holly	9,173	27.58	16.63	0.4	0.0	137	95.5	1.8
E137HL29	(C718H0 x C546) x F80-37	9,141	29.11	15.71	0.2	0.0	159	91.9	1.8
Y231H33	(C718H0 x C546) x Y131	9,131	29.58	15.44	0.0	0.0	151	93.9	1.8
SS Y1	Spreckels	9,088	28.06	16.25	0.3	0.0	159	94.9	2.1
Y246H33	(C718H0 x C546) x Y146	8,847	28.18	15.71	0.0	0.0	156	92.0	1.6
H79228	Spreckels	8,837	27.64	16.00	0.0	0.0	170	94.4	1.9
US H11	546H3 x C36 (80096)	8,522	27.68	15.42	0.0	0.2	158	92.6	1.9
U137H8	546H3 x F80-37 (81060)	8,460	26.39	16.06	0.0	0.2	152	92.6	1.6
Ultramono	Maribo	6,885	20.71	16.63	0.3	1.0	159	92.1	1.6
Mean		9,196	28.69	16.05	0.2	0.1	152	93.6	1.7
LSD (.05)		558	1.61	0.44	0.66	0.4	16	1.2	NS
C. V. (%)		6.1	5.7	2.7	238.6	333.8	10	1.3	34.3
F value		19.9**	23.9**	6.2**	2.4**	2.8**	4.7**	10.5**	0.8 NS

1/ Yields adjusted to clean weight basis.

Note: Natural infection with yellows (BWYV and/or LIY) was moderate.

TEST B183. IMPERIAL VALLEY RETEST OF S_1-TX's, E037HL16[1/], BRAWLEY, CALIFORNIA, 1982-83

16 entries x 6 reps
1-row plots, 24 ft. long

Planted: September 8, 1982
Harvested: May 17, 1983

Variety	Description[2/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Root Rot	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Lbs	Tons	%	%	%	Number	%	Rating
E037HL16-35	755-35aa x C37	10,973	33.71	16.28	0.0	0.0	140	95.1	1.7
E037HL16-27	755-27aa x C37	10,517	31.96	16.45	0.4	0.4	151	93.0	1.8
E037HL16-119	755-119aa x C37	9,991	31.17	16.07	1.0	0.0	150	93.3	1.8
E037HL16-82	755-82aa x C37	9,925	31.10	16.03	0.4	0.0	139	93.7	1.9
E037HL16-48	755-48aa x C37	9,801	30.18	16.26	0.0	0.0	158	92.5	1.8
E037HL16-117	755-117aa x C37	9,672	31.33	15.48	0.0	0.6	161	92.7	1.8
E037HL16-43	755-43aa x C37	9,652	29.36	16.45	0.0	0.0	148	91.5	1.6
E037HL16-129	755-129aa x C37	9,545	28.84	16.57	0.0	0.0	134	93.0	1.3
E037HL16-10	755-10aa x C37	9,332	28.97	16.04	0.0	0.0	149	92.6	1.8
E037HL16-52	755-52aa x C37	9,224	27.78	16.59	0.0	0.0	166	93.0	1.6
E037HL16-29	755-29aa x C37	9,206	28.48	16.16	0.0	0.0	118	93.4	1.8
E137HL6	C301aa x F80-37	10,182	31.08	16.38	0.0	0.0	166	91.6	1.3
E037HL15	755aa x C37	9,907	30.59	16.20	0.0	0.5	164	93.2	1.9
E037H72	C718HO x C37	9,289	29.45	15.78	0.0	0.0	152	92.2	1.5
E137H4	F67-563HO x F80-37	8,876	27.56	16.10	0.0	0.4	152	94.1	1.6
E037H8	F78-546H3 x C37	8,805	27.27	16.11	0.0	0.0	151	93.2	1.4
Mean		9,681	29.93	16.18	0.1	0.1	150	93.1	1.7
LSD (.05)		NS	NS	0.52	NS	NS	21	1.7	NS
C. V. (%)		12	12.0	2.80	462.0	484.5	12	1.6	29.0
F value		1.5NS	1.5NS	2.5**	1.7NS	0.8NS	2.8**	2.3*	1.1NS

1/ In 1980, S_1 families from population 8755 were rogued to genetic male sterile segregates and topcrossed to C37. In 1981, 112 of these S_1-TX's were evaluated in progeny tests at Salinas. On the basis of those tests, 11 of the superior lines were retested in Imperial Valley. (Also see tests 1583 and 1982, page A34.)

2/ Increases of lines 9755-29, -27, -35, -52, -82, and -119 were released as lines C301, C302, C303, C304, C305, and C307, respectively. Population 9755 is a selection from 8755.

Note: Natural infection with yellows (BWYV and/or LIY) was moderate. Because of stand problems, only 6 of 8 reps were harvested. Test has fair reliability.

TEST B283. EVALUATION OF C1 SYN 1 POPULATIONS OF 755 PER SE AFTER FIRST CYCLE OF S_1-TX SELECTION
BRAWLEY, CALIFORNIA, 1982-83

8 entries x 5 reps
2-row plots, 24 ft. long

Planted: September 8, 1982
Harvested: May 17-18, 1983

Variety	Description[1/]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolting %	Root Rot %	Beets/ 100' Number	Clean Beets %	Nitrate Nitrogen Rating
2757	1757aa x A	9,593	29.77	16.10	0.0	0.0	135	96.8	1.3
2755F	9755-S_1(LSY)aa x A	8,887	28.67	15.48	0.0	0.0	133	96.9	1.7
8755	7755Baa x A	8,845	27.45	16.11	0.0	0.0	134	95.8	1.0
2755D	9755-S_1(SY)aa x A	8,822	28.56	15.44	0.0	0.0	131	95.0	1.7
2755	1755aa x A	8,551	27.02	15.84	0.3	0.0	119	95.1	1.5
2755C	9755-S_1(Check)aa x A	8,486	27.01	15.70	0.0	0.0	117	96.3	1.7
2755G	9755-S_1(L%S)aa x A	8,277	27.45	15.07	0.0	0.4	114	95.9	1.2
2755E	9755-S_1(%S)aa x A	8,226	25.34	16.22	0.0	0.0	131	96.3	1.1
Mean		8,711	27.66	15.75	0.0	0.1	127	96.0	1.4
LSD (.05)		NS	NS	0.53	NS	NS	NS	1.02	NS
C. V. (%)		10	9.40	2.60	632.5	632.5	16	0.8	43.8
F value		1.3NS	1.3NS	4.7**	1.0NS	1.0NS	0.9NS	4.0**	1.1NS

1/ See footnotes for Test 283-1.

Note: Natural infection with yellows moderate. Due to poor stands, only 5 of 8 replications harvested.

TEST B383. GCA EVALUATION OF C1 SYN 1 POPULATIONS OF 755 WITH 1747 AFTER FIRST CYCLE OF S_1-TX SELECTION
BRAWLEY, CALIFORNIA, 1982-83

8 entries x 6 reps
2-row plots, 24 ft. long

Planted: September 8, 1982
Harvested: May 18, 1983

Variety	Description[1/]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Bolting	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Lbs	Tons	%	%	Number	%	Rating
2757H53	1747aa x 1757	9,771	31.58	15.45	0.8	126	94.3	2.1
2755CH53	1747aa x 9755-S_1 (Check)	9,612	31.49	15.27	0.8	128	93.6	2.0
2755FH53	1747aa x 9755-S_1(LSY)	9,569	31.35	15.24	0.7	118	95.6	2.4
2755DH53	1747aa x 9755-S_1(SY)	9,409	31.62	14.89	1.4	113	94.8	2.4
2747H54	1755aa x 1747	9,248	31.44	14.72	0.2	141	93.4	2.6
2755GH53	1747aa x 9755-S1(L%S)	9,045	30.06	15.02	0.4	110	95.1	2.5
2755H53	1747aa x 1755	8,961	30.29	14.78	0.0	108	93.7	2.1
2755EH53	1747aa x 9755-S_1(%S)	8,602	28.80	14.94	0.0	119	94.5	2.2
Mean		9,277	30.83	15.04	0.5	120	94.4	2.3
LSD (.05)		764	NS	0.51	NS	21	NS	NS
C. V. (%)		7	6.10	2.90	173.0	15	1.4	24.2
F value		2.2*	1.8NS	2.1*	1.6NS	2.2*	1.9NS	1.0NS

1/ See footnotes for Test 283-1 and 383-1.

Note: Natural infection with yellows moderate. Due to poor stands, only 6 of 8 replications harvested.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT LOGAN, 1983
150 entries x 2 replications

Variety	Description	CT Grade 8/26	CT Grade 9/20	Variety	Description	CT Grade 8/26	CT Grade 9/20
HYBRIDS				HYBRIDS			
US H10B	C546H3 x C17	2.5	3.0	US H11	C546H3 x C36	3.5	3.0
964H8	" x C64	2.5	2.5	U236H6	(566CMS x 546) x C36	1.5	2.0
US H11	" x C36	1.5	1.5	Ultramono	Maribo	5.5	7.0
U137H8	" x C37	1.5	1.5	SSY1	Spreckels	3.5	4.0
E137H4	C563CMS x C37	2.5	2.5	2C0105	Betaseed	4.5	4.5
E137H8	C546H3 x C37	1.5	1.5	HH37	Holly	4.5	4.5
E137H72	C718CMS x C37	2.0	2.0	313.703-2	Maribo	4.5	4.5
E137HL2	755aa x C37	3.0	2.5	Y231H8	C546H3 x C31E4	4.0	4.5
E137HL4	757aa x C37	2.5	2.5	Y231H16	755CMS x C31E4	4.0	4.0
US 33	Check variety	5.5	5.5	US 33	Check variety	5.0	6.0
E137HL6	C301aa x C37	2.5	2.5	Y231H19	796CMS x C31E4	3.5	4.0
E137HL29	(C718CMS x C546) x C37	2.0	2.0	Y246H3	C562HO x C46	3.0	3.0
U031H8	C546H3 x C31E2	4.5	4.5	Y246H8	C546H3 x C46	3.0	3.5
704-13H24	(536CMS x 522) x 04-13	2.5	3.0	Y246H15	C301CMS x C46	2.0	2.5
Y141H8	C546H3 x Y41	4.0	4.0	Y246H16	755CMS x C46	2.5	2.5
Y146H8	C546H3 x C46	3.0	3.0	Y246H21	(C718CMS x C301) x C46	3.5	3.5
Y149H8	C546H3 x Y49	4.0	4.0	Y246H33	(C718CMS x C546) x C46	2.0	3.0
Y152H8	C546H3 x Y52	3.5	3.5	Y246H42	(C301CMS x C546) x C46	2.5	2.5
1757HL9	747aa x 757	2.5	3.0	Y246H54	755aa x C46	2.5	3.0
BJ19	Bush-Johnson's	6.0	7.0	Y246H56	757aa x C46	2.0	2.0
US 41	Check variety	4.0	4.0	US 41	Check variety	4.0	4.5
E137HL45-16	S_1 755-16aa x C37	2.5	3.0	Y246H58	742aa x C46	3.5	3.5
E137HL45-51	S_1 755-51aa x C37	3.0	3.0	Y246H61	C301aa x C46	3.5	3.5
E137HL45-26	S_1 755-26aa x C37	3.5	3.5	Y246H63	1214aa x C46	3.5	3.5
E137HL45-70	S_1 755-70aa x C37	3.5	3.5	Y246H64	1216aa x C46	3.5	3.5
E137HL45-22	S_1 755-22aa x C37	3.0	3.0	Y254H8	C546H3 x Y54	2.5	3.0
E137HL45-46	S_1 755-46aa x C37	2.0	2.0	2747H8	C546H3 x 747	2.5	2.5
2747H16	755CMS x 747	3.0	3.0	2755H53	747aa x 755	3.5	3.5

CURLY TOP EVALUATION OF SALINAS ENTRIES AT LOGAN, 1983
150 entries x 2 replications

Variety	Description	CT Grade 8/26	CT Grade 9/20
OPEN-POLLINATED LINES			
US 33	Check variety	5.0	5.0
Y009	US 22/3	2.5	3.0
968	US 75	3.0	3.0
917	C17	4.5	4.0
F80-37	C37	4.0	4.0
F81-37	C37	3.5	3.5
F78-36	C36	4.0	4.0
964	C64	3.5	3.5
904-15ER	04-15	4.0	4.0
F79-31	C31E2	6.5	7.0
Y231	C31E4	5.5	6.0
Y231H53	747aa x C31E4	5.0	5.5
Y139	Y39	6.0	6.0
US 41	Check variety	4.0	4.5
Y141 (Iso)	Y41	5.5	5.5
Y042	C42	4.0	5.0
F82-36	C36	3.0	3.5
F82-46	C46	3.5	3.5
Y146 (Sp)	C46	5.0	5.5
Y246	C46	3.0	3.5
Y246H53	747aa x C46	4.0	4.0
Y147	Y47	4.5	4.5
Y148	Y48	4.0	4.0
Y149	Y49	4.5	5.0
Y249	Y49	5.0	5.5
Y152	Y52	3.0	3.5
US 33	Check variety	5.0	6.0
Y252	Y52	4.0	4.5
OPEN-POLLINATED LINES			
Y253(3n)	4n x 2n	5.5	6.5
Y254	Y54	4.5	4.5
Y254H53	747aa x Y54	3.0	4.0
US 41	Check variety	3.5	4.0
SELF-FERTILE LINES			
2747	747	3.5	4.5
US 41	Check variety	4.0	5.0
1747	747	4.0	4.5
1748 (Iso)	748	3.0	3.5
1796	796	3.0	3.5
1790D	790	3.5	4.0
2790	790	4.0	4.0
2797	797	3.0	3.0
2731	731	6.0	6.5
US 33	Check variety	5.5	6.0
0740	740	4.0	5.0
2741	741	3.5	4.5
2742	742	4.0	5.0
2744	Inc. C789	4.0	4.0
2745	745	3.5	4.0
2755	755	4.0	5.0
2755D	755D	3.5	3.5
2755E	755E	3.0	3.0
2757	757	3.0	3.5
0755 (Sp)	755	3.5	4.0
1755 (Iso)	755	4.0	5.0
1757 (Sp)	757	4.0	5.0
US 41	Check variety	4.0	5.0
2804A	757	4.0	4.5

CURLY TOP EVALUATION OF SALINAS ENTRIES AT LOGAN, 1983
150 entries x 2 replications

Variety	Description	CT Grade 8/26	CT Grade 9/20	Variety	Description	CT Grade 8/26	CT Grade 9/20
SELF-FERTILE LINES							
1759	759	3.0	3.5	F81-566	C566	3.5	3.5
F78-546H3	C546H3	3.0	3.5	8563	C563	3.0	3.0
F81-546H3	C546H3	3.0	3.5	8563HO	C563CMS	3.5	3.0
F82-546H3	C546H3	3.5	3.0	0562	C562	4.0	3.5
1546H72	C718CMS x C546	2.5	2.5	0562HO	C562CMS	3.5	3.5
1546HL5	C301CMS x C546	2.5	2.5	F78-546	C546	4.0	4.5
7522H21	C536CMS x C522	2.5	2.5	1546 (Sp)	C546	4.0	4.5
1755-29H72	C718CMS x C301	3.0	3.0	9718	C718	3.0	3.5
2802	755	3.0	3.0	9718HO	C718CMS	2.0	2.5
2803	755	3.5	3.5	2212C1	2212	2.0	2.5
US 33	Check variety	5.0	5.0	1214	1214	4.5	5.0
2805A	C304	4.0	5.0	1216	1216	3.5	4.5
2806A	C305	3.5	3.5	1218C1	1218	5.0	6.0
2807A	C306	3.5	3.5	1219C1	1219	4.5	5.0
2808A	C307	3.5	4.0	1220C1	1220	5.0	6.0
2809A	C302	4.0	4.0	1221C1	1221	4.5	5.5
2810A	C303	3.0	3.0	Y246H57-7	S_1 757-7aa x C46	3.0	3.5
0755-18	S_2 755-18	3.5	3.0	Y246H57-10	S_1 757-10aa x C46	2.5	3.0
0755-43	S_2 755-43	3.5	3.5	Y246H57-33	S_1 757-33aa x C46	2.5	2.5
1755-29	S_2 755-29 (C301)	3.5	4.5	Y246H57-28	S_1 757-28aa x C46	2.0	2.0
US 41	Check variety	4.0	4.5	US 33	Check variety	5.0	5.5
F82-301	C301	4.0	4.5	Y246H57-34	S_1 757-34aa x C46	3.0	3.5
F82-301CMS	C301CMS	3.0	3.5	Y246H56	757aa x C46	3.0	3.5
F82-546	C546	3.5	4.5	C35-1	C35-1	5.5	5.5
F82-562	C562	3.5	3.5	C35-2	C35-2	4.5	4.5
F82-562HO	C562CMS	4.0	4.0	C35-1/2	C35-1/2	5.5	6.0
US 33	Check variety	5.5	6.0	US 41	Check variety	4.0	4.5

POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983

R. T. Lewellen, I. O. Skoyen, and E. D. Whitney

Two combined PM and ERR evaluation trials with 288 entries were grown at Salinas. At the research station, two reps were grown, and at Spence field, one additional rep was grown. Because of differences in disease reactions and cultural practices, all three reps are summarized separately.

1/ Spence Field. Planted May 20, 1983. Plots 1-row, 27 ft long. Inoculated with Erwinia August 3. Scored for ERR November 1. PM infection very late and mild. ERR uniform and severe.

2/ Research Station. Planted April 26, 1983. Plots 1-row, 16 ft long, 2 reps. Inoculated with PM May 22. Inoculated with Erwinia July 7. Inoculated with BWYV May 14. Differences in BWYV symptoms obliterated by rhizomania and other diseases - no scores taken. PM infection very severe. ERR infection uniform and severe. Scored for ERR October 24-26.

3/ Seedling survival. At Spence, a severe damping-off and seedling root problem occurred that reduced stands and seedling vigor. Plots were scored for survival and vigor (0 = normal, 6 = all plants dead).

4/ Powdery mildew. Ratings made on a scale of 0 to 9. Natural infection at Spence late and mild. Inoculated at Salinas and severe. Disease development in rep I[6/] earlier than rep II and rating of 8/12 for rep I only with gradient from high to low progressing through the test (upwind).

5/ Erwinia. Ratings for ERR at harvest. DI = Disease Index = mean % rot/root. Plants scored on a scale of 0, 1, 7, 25, 50, 75, 93, and 100% rot per root. Roots with scores of 0 and 1% rot were considered resistant. E140 and E240 (C40) and US H10 (917H8) were ERR susceptible checks. US H11, C36, and C546 were ERR resistant checks. Comparisons should primarily be made within sets of entries (denoted by dotted lines).

6/ See 4/.

7/ Rhizomania. This is the first test (field) in California in which rhizomania was positively identified (bearded roots with confirmed presence of Polymyxa betae and BNYVV). Rhizomania severity occurred in a gradient from mild on the south side of the plot to severe on the north side, where the plot overlapped on area planted to beets in 1981. This overlap occurred for about 6-8 plot rows into this test. Rhizomania did not appear to influence the reaction of the entries to powdery mildew but did confound the ratings for erwinia root rot. At Salinas, there were 32 entries per block across this plot field. The order of the entries in the first and second reps was reversed. The letters "M" and "S" have been placed on the summary tables to indicate the start and end of each set of 32 entries and the relative disease gradient from M = mild to S = severe rhizomania.

Rhizoctonia root rot. Rhizoctonia root rot was also quite severe in the 6-8 rows where the overlap occurred and also confounded the ERR scoring for these plots. Therefore, the most reliable data for ERR is probably for the side of the block away from the overlapped area.

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983

Test 2183-2 (Spence Field), 1 Rep[1/]

Variety	Description	No. Roots	Seedling Survival[3/] 7/4	7/14	P.M.[4/] Score 9/20	Erwinia Reaction[5/] DI	% Resist.
HYBRIDS							
US H11	(282110)	31	3	2	2	2.3	83.9
US H10B	(3084)	23	4	4	2	25.8	56.5
964H8	546H3 x 364 (C64)	30	3	2	3	2.7	80.0
HH27	Holly	25	4	4	2	1.3	92.0
H81180	SS-MS x C42	34	4	2	3	7.2	76.5
BJ19	Bush-Johnsons	31	3	2	2	21.0	67.7
9421	Betaseed (098)	34	3	2	3	24.3	58.8
Monoricca	Hilleshog	37	3	2	2	13.5	81.1
GW 149	GW (7033)	44	2	2	4	29.1	52.3
Monohy D2	GW	36	3	2	4	24.1	58.3
Ultramono	Maribo	40	2	2	4	28.6	52.5
313.702-2	Maribo	30	3	3	4	40.4	36.7
313.703-2	Maribo	34	4	3	4	42.4	32.4
U137H8	546H3 x C37 (81060)	36	3	2	4	12.7	72.2
U031H8	546H3 x C1E2 (080212)	29	4	2	2	12.1	62.1
HH37	Holly	38	4	2	2	25.8	50.0
US H11	(282110)	42	2	2	5	1.0	88.1
917H8	F/O-546H3 x 417 (C17)	34	3	2	4	43.3	38.2
U236H6	(566HO x 546) x C36	47	2	2	4	2.7	87.2
E137H4	F67-563HO x F80-37	41	2	2	4	18.2	73.2
E137H8	F78-546H3 x F80-37	47	2	2	4	2.1	87.2
E137H72	C718HO x F80-37	45	3	2	4	9.3	82.2
E137HL29	(718 x 546) x F80-37	43	3	2	4	0.0	100.0
E137HL1	0755HO x F80-37	45	2	2	3	5.9	89.0
E137HL2	0755aa x F80-37	41	2	2	4	17.1	68.3
E137HL5	C301CMS x F80-37	44	2	2	3	11.7	70.5
E137HL6	C301aa x F80-37	39	3	2	4	7.1	74.4
Y231H8	F78-546H3 x Y131 (C31E2)	42	3	3	4	9.0	81.0
Y231H33	(718 x 546) x Y131	42	3	2	0	18.3	73.8
Y231H16	0755HO x Y131	30	3	3	2	27.3	53.3
Y231H19	1796HO x Y131	37	3	3	0	23.3	54.1
E140	ERR susc. check	49	4	5	4	82.2	12.2
E137HL45-16	0755-16aa x F80-37	37	3	3	2	6.2	83.8
E137HL45-22	0755-22aa x F80-37	19	5	6	0	15.1	68.4
E137HL45-26	0755-26aa x F80-37	29	4	3	2	21.6	65.5
E137HL45-30	0755-30aa x F80-37	37	3	2	4	16.1	75.7
E137HL45-46	0755-46aa x F80-37	47	2	1	6	12.2	80.9
E137HL45-51	0755-51aa x F80-37	31	3	2	2	17.0	74.2
E137HL45-53	0755-53aa x F80-37	45	2	1	3	12.0	80.0
E137HL45-70	0755-70aa x F80-37	39	3	2	2	19.5	71.8
E137HL45-87	0755-87aa x F80-37	35	4	3	5	11.2	77.1
E137H8	F78-546H3 x F80-37	36	3	3	5	5.5	77.8
917H8	F70-546H3 x C17	44	2	1	6	11.9	63.6

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)[2/]

Variety	Powdery Mildew Score[4/] 8/12[6/]	8/18	8/29	Erwinia Reaction[5/] Replication I No.	DI	% Resist.	Replication II No.	DI	% Resist.
HYBRIDS						M[7/]			S[7/]
US H11	6.0	6.0	7.5	24	1.3	91.7	25	0.3	96.0
US H10B	6.0	5.5	6.5	25	14.8	76.0	28	43.3	50.0
964H8	3.0	5.0	6.5	22	0.3	95.5	22	21.7	77.3
HH27	2.0	4.0	4.5	23	8.7	87.0	20	10.9	85.0
H81180	4.0	4.5	7.0	23	8.1	91.3	21	0.4	95.2
BJ19	4.0	4.5	5.0	22	27.4	63.6	22	21.0	72.7
9421	5.0	5.5	6.5	24	36.1	58.3	22	12.2	81.8
Monoricca	2.0	4.0	4.5	21	5.0	95.2	22	6.8	90.9
GW 149	6.5	6.0	8.5	24	21.3	66.7	22	10.3	81.8
Monohy D2	4.0	5.5	7.5	24	4.2	91.7	27	5.6	92.6
Ultramono	2.0	4.5	4.0	24	19.0	79.2	24	14.6	83.3
313.702-2	5.5	6.0	7.0	29	11.1	86.2	23	32.0	60.9
313.703-2	6.0	6.0	7.0	26	23.6	69.2	24	26.1	54.2
U137H8	6.0	6.5	7.5	24	3.9	95.8	25	2.4	88.0
U031H8	4.5	5.5	5.5	26	0.0	100.0	21	9.5	85.7
HH37	3.0	5.5	6.0	28	4.5	92.9	24	29.5	50.0
US H11	6.5	7.0	8.0	25	0.1	100.0	21	4.4	95.2
917H8	6.5	7.0	7.5	25	9.7	72.0	22	23.9	63.6
U236H6	6.5	7.0	8.0	21	0.3	95.2	22	9.1	81.8
E137H4	7.0	6.5	6.0	23	19.3	69.6	19	10.5	78.9
E137H8	7.5	6.5	7.0	25	1.6	88.0	21	10.4	85.7
E137H72	7.0	7.0	6.5	20	20.7	75.0	25	7.1	76.0
E137HL29	7.0	7.0	6.5	27	4.1	92.6	23	5.1	82.6
E137HL1	7.0	7.0	6.5	24	0.4	95.8	26	15.4	73.1
E137HL2	6.0	6.5	6.5	24	0.0	100.0	21	11.1	76.2
E137HL5	6.0	6.5	7.0	24	9.4	83.3	22	17.6	81.8
E137HL6	6.5	6.0	7.0	18	6.3	83.3	17	10.7	76.5
Y231H8	3.0	5.5	6.0	23	3.9	87.0	24	6.0	91.7
Y231H33	4.0	5.5	5.5	18	13.9	83.3	20	18.4	65.0
Y231H16	2.5	5.0	5.0	23	22.1	73.9	20	24.4	70.0
Y231H19	3.0	6.0	5.0	19	6.6	89.5	17	28.6	58.8
E140	7.0	7.0	7.5	25	85.6	S 8.0	24	98.3	M 0.0
E137HL45-16	5.5	7.0	8.0	20	9.7	M 85.0	20	22.2	S 70.0
E137HL45-22	3.0	5.5	6.0	27	15.3	77.8	23	17.4	69.6
E137HL45-26	5.0	6.0	7.0	22	9.1	90.9	29	23.3	72.4
E137HL45-30	5.0	6.0	7.0	22	4.3	95.5	19	22.4	68.4
E137HL45-46	6.0	6.5	7.5	22	4.6	95.5	22	8.0	90.9
E137HL45-51	5.0	5.0	6.0	21	6.3	85.7	17	4.9	88.2
E137HL45-53	4.0	5.0	6.0	22	17.9	72.7	24	8.4	87.5
E137HL45-70	3.0	4.5	4.5	21	3.6	95.2	25	8.7	76.0
E137HL45-87	7.0	6.5	7.0	19	14.1	84.2	20	31.3	50.0
E137H8	6.0	6.0	7.5	21	4.9	90.5	25	10.6	80.0
917H8	5.0	5.5	7.0	23	8.7	91.3	26	24.2	61.5

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
Y246H3	C562HO x Y146 (C46)	39	4	5	5	9.2	74.4
Y246H8	F78-546H3 x Y146	38	4	4	3	3.5	84.2
Y246H9	546H3 x Y146	33	4	4	2	8.4	75.8
Y246H33	(718HO x 546) x Y146	37	3	2	3	19.0	64.9
Y246H72	C718HO x Y146	31	4	3	3	28.5	45.2
Y246H41	(757 x 546) x Y146	30	3	3	2	7.3	80.0
Y246H42	(C301 x 546) x Y146	30	3	3	3	7.0	86.7
Y246H61	C301aa x Y146	36	3	2	4	11.4	80.6
Y246H15	C301CMS x Y146	31	4	2	4	18.4	74.2
Y246H21	(301 x 718) x Y146	29	4	3	4	17.7	69.0
Y246H16	0755HO x Y146	46	3	2	2	5.2	73.9
Y246H22	(718 x 755) x Y146	29	4	4	3	8.9	79.3
Y246H54	1755aa x Y146	32	4	4	2	9.2	81.3
Y246H56	1757aa x Y146	34	4	3	3	9.5	73.5
Y246H58	0742aa x Y146	34	3	2	2	13.4	82.4
Y246H69	1790aa x Y146	37	3	2	2	9.4	78.4
Y246H63	1214aa x Y146	41	3	2	2	6.7	82.9
Y246H64	1216aa x Y146	33	4	3	2	3.9	87.9
Y254H8	F78-546H3 x 1201-5	28	4	4	3	6.8	78.6
Y254H16	0755HO x 1201-5	37	2	2	2	20.6	62.2
US H10B	(3084)	42	3	2	4	15.6	69.0
Y246H57-7	1757-7aa x Y146	33	3	2	3	12.2	60.6
Y246H57-10	1757-10aa x Y146	35	3	2	2	21.9	68.6
Y246H57-26	1757-26aa x Y146	28	4	4	2	14.6	64.3
Y246H57-33	1757-33aa x Y146	30	5	4	2	27.3	56.7
Y246H57-34	1757-34aa x Y146	45	4	2	3	19.9	66.7
US H11	(282110)	47	3	2	4	0.3	95.7
2747H8	F78-546H3 x 747	45	3	2	5	13.8	77.8
2747H16	0755HO x 747	35	4	2	5	8.7	88.6
2747H54	1755aa x 747	37	3	2	4	13.4	70.3
2747H56	1757aa x 747	39	2	2	4	13.6	74.4
2755H53	747aa x 1755	39	2	2	4	9.1	79.5
2755DH53	747aa x 9755-S_1 (SY)	30	3	1	4	3.3	80.0
2755EH53	747aa x 9755-S_1 (% S)	38	3	1	4	22.6	63.2
2757H53	747aa x 1757	35	3	1	5	16.4	65.7
Y231H53	747aa x Y131	44	2	1	4	3.9	84.1
Y246H53	747aa x Y146	44	2	1	5	5.5	86.4
Y254H53	747aa x 1201-5	37	3	2	4	5.7	81.1
E0206	Amalgamated	39	2	2	5	1.3	89.7
E0207	Amalgamated	43	2	2	5	1.4	95.3
E0209	Amalgamated	40	2	2	5	4.6	85.0
US H11	(282110)	44	2	2	5	4.7	79.5
F82-546	(82372)	33	5	5	4	6.0	81.8

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)[2/]

Variety	Powdery Mildew Score			Erwinia Reaction					
				Replication I			Replication II		
	8/12	8/18	8/29	No.	DI	% Resist.	No.	DI	% Resist.
Y246H3	3.0	5.5	6.5	24	0.3	95.8	21	13.5	76.2
Y246H8	2.0	4.5	5.5	19	3.9	94.7	22	12.6	81.8
Y246H9	4.0	5.0	5.5	26	13.5	84.6	22	12.8	81.8
Y246H33	4.0	5.5	7.0	27	0.0	100.0	22	0.0	100.0
Y246H72	4.0	5.0	5.0	23	17.9	78.3	23	16.7	73.9
Y246H41	2.5	5.0	5.0	27	8.1	88.9	27	0.3	96.3
Y246H42	4.0	5.0	5.0	22	1.5	90.9	22	8.1	86.4
Y246H61	5.0	5.5	5.5	23	9.5	87.0	23	7.3	91.3
Y246H15	6.0	5.5	6.0	16	0.0	100.0	23	13.6	82.6
Y246H21	4.0	5.0	5.0	22	2.4	95.5	23	19.7	73.9
Y246H16	3.0	5.0	4.5	28	7.7	82.1	20	27.2	65.0
Y246H22	4.0	5.0	4.5	27	21.5	77.8	25	31.0	56.0
Y246H54	5.0	5.5	5.0	25	0.0	100.0	25	3.7	96.0
Y246H56	3.0	4.5	5.0	21	2.8	90.5	24	25.5	62.5
Y246H58	2.0	4.5	5.5	18	32.9	55.6	21	36.6	61.9
Y246H69	2.0	4.5	5.0	23	17.8	73.9	20	15.7	70.0
Y246H63	2.0	4.0	5.0	21	18.2	76.2	21	12.5	85.7
Y246H64	2.0	4.5	5.5	22	10.0	86.4	22	20.5	68.2
Y254H8	2.0	5.0	6.0	20	0.5	95.0	21	9.1	81.0
Y254H16	2.0	4.5	5.5	23	5.4	91.3	21	35.4	52.4
US H10B	4.0	5.5	7.0	25	9.4	84.0 S	22	38.4	54.5 M
Y246H57-7	4.0	6.5	6.0	25	8.4	80.0 M	20	30.9	65.0 S
Y246H57-10	2.0	5.0	5.5	26	51.4	38.5	25	41.5	52.0
Y246H57-26	3.0	4.5	5.0	24	46.6	45.8	22	22.4	68.2
Y246H57-33	2.0	4.0	4.5	20	23.5	65.0	22	28.1	68.2
Y246H57-34	1.0	4.5	5.5	25	42.8	52.0	24	16.1	79.2
US H11	4.0	6.0	6.5	24	0.8	91.7	26	7.2	92.3
2747H8	4.0	5.5	5.5	25	10.5	88.0	23	0.0	100.0
2747H16	3.0	5.5	5.0	26	20.0	73.1	25	16.8	80.0
2747H54	5.0	6.0	5.0	23	28.4	65.2	27	3.1	92.6
2747H56	5.0	6.0	5.5	24	13.8	70.8	24	3.4	83.3
2755H53	3.5	5.5	5.5	20	26.6	50.0	24	7.8	91.7
2755DH53	2.0	5.5	5.5	22	8.6	90.9	19	32.6	57.9
2755EH53	2.0	4.5	5.0	18	9.8	83.3	21	23.1	76.2
2757H53	3.0	5.0	5.5	21	25.6	71.4	19	10.9	84.2
Y231H53	4.0	5.0	5.5	24	0.0	100.0	20	16.8	75.0
Y246H53	3.0	5.0	5.5	24	20.3	79.2	21	4.9	90.5
Y254H53	5.0	5.5	5.5	19	0.1	100.0	19	10.2	89.5
E0206	7.0	5.5	7.5	26	0.4	96.2	24	11.2	87.5
E0207	6.0	5.5	7.0	26	0.0	100.0	23	3.6	91.3
E0209	6.0	6.0	7.5	23	1.2	95.7	23	6.2	91.3
US H11	6.0	6.0	7.5	23	4.1	95.7	24	0.4	95.8
F82-546	5.0	5.0	5.0	22	13.4	86.4	28	6.8	85.7

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
Female #1	Amalgamated	54	2	2	4	1.4*	89.1
Female #2	Amalgamated	53	4	2	2	0.0*	100.0
Male #1	Amalgamated	1	6	6	-	0.0*	100.0
Male #2	Amalgamated	42	4	5	0	0.0*	100.0
E0107	1 x 2 Amalgamated	49	2	2	4	0.0*	100.0
E2196	(1 x 2) x M Amalgamated	52	2	2	4	1.4*	96.2
E1148	(1 x 2) x 2 Amalgamated	49	2	2	3	0.0*	100.0
E2153	(1 x 2) x 1 Amalgamated	37	3	2	4	0.0*	100.0
E1152	(2 x F) x 2 Amalgamated	46	3	2	2	0.0*	100.0
E2148	(2 x F) x 1 Amalgamated	35	4	4	3	0.0*	100.0
SS-1	S-101H	15	5	5	5	20.5	46.7
SS-2	SS-Z1	24	4	4	3	13.3	62.5
SS-3	S-311H	39	3	2	2	13.6	74.4
SS-4	SS-Y1	42	2	2	3	6.7	78.6
SS-5	H79251	37	2	2	2	2.3	89.2
SS-6	SS-NB1	36	3	2	2	2.8	94.4
SS-7	SS-E2	38	2	2	4	2.6	97.4
SS-8	SS-X713DC	39	2	2	5	2.3	94.9
SS-9	H80182	39	2	2	3	1.1	92.3
SS-10	H81202	40	2	2	3	0.1	100.0
SS-11	H82316	32	3	2	4	3.5	90.6
SS-12	SSR1	38	3	2	5	5.6	89.5
US H10B	(3084)	38	3	2	4	20.1	55.3
US H11	(282110)	33	2	2	5	4.9	78.8
EM 16	Mennesson	37	2	2	3	24.4	54.1
EM 17	Mennesson	32	3	2	4	24.9	56.3
EM 18	Mennesson	36	3	2	4	32.9	44.4
EM 19	Mennesson	41	2	2	2	29.3	53.7
EM 21	Mennesson	35	3	2	3	11.1	77.1
EM 23	Mennesson	45	3	2	3	20.7	60.0
EM 30	Mennesson	37	3	2	3	31.3	48.6
EM 40	Mennesson	44	2	2	2	31.2	50.0
Hill-1	HK 42 415	37	4	4	4	0.7*	97.3
Hill-2	HK 48 564	24	5	5	0	0.0*	100.0
Hill-3	KK 14176	6	5	6	0	0.0*	100.0
Hill-4	HK 64219	33	4	2	2	0.0*	100.0
Hill-5	HK 64223	36	4	2	2	2.8*	97.2
Hill-6	KK 14334	33	4	2	2	0.0*	100.0
Hill-7	VL 94164	32	5	5	0	3.1*	96.9
Hill-8	VK 14149	40	4	2	2	0.2*	97.5
Hill-9	HK 48947	34	4	5	4	0.0*	100.0
Hill-10	KK 14167	12	5	6	4	0.0*	100.0

*Not wound-inoculated with Erwinia

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)

Variety	Powdery Mildew Score			Erwinia Reaction					
				Replication I			Replication II		
	8/12	8/18	8/29	No.	DI	% Resist.	No.	DI	% Resist.
Female #1	4.0	3.5	4.5	21	5.5	85.7	27	21.2	66.7
Female #2	1.0	1.5	3.5	25	15.6	80.0	27	14.3	85.2
Male #1	2.0	2.0	6.0	20	72.5	25.0	23	63.8	34.8
Male #2	1.0	1.0	1.5	19	9.6	84.2	22	8.8	86.4
E0107	2.0	4.0	4.5	22	22.7	63.6	22	17.6	77.3
E2196	3.0	4.5	6.5	25	52.5	40.0	22	48.3	40.9
E1148	1.0	1.0	2.0	23	11.0	78.3	23	22.0	69.6
E2153	3.0	5.0	7.5	23	37.5	56.5	27	46.9	51.9
E1152	1.0	2.0	1.0	29	17.8	69.0	20	16.3	70.0
E2148	5.0	5.5	7.5	25	0.0	100.0	26	13.5	73.1
				S			M		
SS-1	4.0	6.0	6.5	21	14.3	81.0	17	29.4	64.7
				M			S		
SS-2	4.0	6.0	6.5	21	10.4	85.7	26	24.9	61.5
SS-3	2.0	4.5	4.0	19	5.3	89.5	24	17.3	70.8
SS-4	2.0	4.5	5.0	22	16.8	77.3	23	13.9	78.3
SS-5	2.5	5.5	6.0	21	12.4	85.7	26	13.8	69.2
SS-6	2.0	5.0	5.5	24	0.0	100.0	24	4.5	87.5
SS-7	4.0	6.5	7.5	22	0.3	95.5	25	0.1	100.0
SS-8	4.0	6.5	6.5	23	5.8	87.0	27	0.1	100.0
SS-9	5.0	7.0	7.0	22	6.8	90.9	24	5.4	91.7
SS-10	5.0	6.5	6.0	23	2.3	91.3	23	2.1	82.6
SS-11	3.0	6.0	6.5	22	6.8	86.4	29	5.2	93.1
SS-12	4.0	6.0	5.5	18	5.2	94.4	24	13.1	79.2
US H10B	5.0	6.5	7.0	22	20.5	72.7	23	43.2	39.1
US H11	5.0	7.0	7.0	26	2.9	96.2	24	6.0	83.3
EM 16	3.0	5.0	5.0	25	10.7	88.0	26	17.0	80.8
EM 17	2.0	5.0	4.5	23	18.2	73.9	25	1.9	84.0
EM 18	2.0	4.5	5.0	22	0.7	90.9	27	6.5	88.9
EM 19	2.0	4.5	5.0	25	9.4	80.0	23	17.8	65.2
EM 21	2.0	4.5	4.5	23	8.8	87.0	24	9.6	70.8
EM 23	3.0	5.0	5.0	23	17.2	78.3	24	22.0	66.7
EM 30	3.0	5.0	5.0	18	5.3	94.4	20	27.0	60.0
EM 40	3.0	4.5	5.0	18	12.2	77.8	25	22.9	68.0
Hill-1	4.5	5.5	6.0	25	0.0*	100.0	20	0.0*	100.0
Hill-2	4.0	5.5	5.0	25	0.0*	100.0	28	2.7*	96.4
Hill-3	1.0	2.0	2.0	12	82.2*	16.7	15	6.2*	93.3
Hill-4	3.0	4.5	5.0	22	0.0*	100.0	20	0.0*	100.0
Hill-5	4.0	5.5	4.0	23	4.4*	95.7	24	4.2*	95.8
Hill-6	4.0	5.5	6.0	21	4.8*	95.2	21	4.4*	95.2
Hill-7	1.0	2.5	1.5	23	4.4*	95.7	27	0.0*	100.0
Hill-8	5.0	6.0	7.0	21	0.0*	100.0	25	0.0*	100.0
Hill-9	5.0	6.0	8.5	18	10.7*	88.9	23	0.0*	100.0
Hill-10	4.0	5.0	5.0	19	49.6*	47.4	23	38.0*	56.5
					S			M	

*Not wound-inoculated with Erwinia

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
H1	Holly	24	3	4	2	20.9	66.7
H2	Holly	14	5	6	2	18.4	57.1
H3	Holly	39	2	2	2	1.1	92.3
H4	Holly	38	2	2	3	10.7	86.8
H5	Holly	39	3	2	3	10.0	79.5
H6	Holly	42	4	2	3	27.0	64.3
H7	Holly	35	2	2	4	23.6	65.7
H8	Holly	40	3	2	2	4.4	92.5
H9	Holly	34	3	2	3	12.0	73.5
H10	Holly	37	3	2	4	22.5	56.8
H11	Holly	34	3	2	3	20.9	61.8
H12	Holly	30	3	2	4	12.8	60.0
US H10B	(3084)	40	3	2	5	16.7	60.0
US H11	(282110)	41	2	2	6	2.9	87.8
Y246H8	546H3 x Y146	39	3	2	5	2.3	89.7
E140	ERR susc. check	34	4	2	-	72.4	5.9
2C0107	Betaseed	52	2	2	2	8.8	86.5
2C0104	Betaseed	54	3	2	2	11.0	75.9
2C0105	Betaseed	41	3	2	3	12.5	75.6
2C0106	Betaseed	54	3	2	4	2.8	90.7
2G5543	Betaseed	44	3	2	5	9.3	72.7
2G5545	Betaseed	48	3	2	5	15.2	62.5
2G5539	Betaseed	43	2	2	3	20.0	60.5
2G5540	Betaseed	39	4	2	2	18.3	56.4
2G5541	Betaseed	43	3	2	2	10.2	79.1
2C0114	Betaseed	37	3	2	2	2.8	94.6
US H11	(282110)	45	3	2	5	3.2	95.6
OPEN-POLLINATED LINES							
E240	Inc. E640	46	3	2	-	79.5	15.2
917	Inc. 417 (C17)	48	2	2	3	51.5	39.6
F82-36	Inc. C36 (82421)	41	3	2	4	1.2	95.1
F81-37	Inc. F80-37 (81101)	44	3	2	4	4.6	93.2
F82-46	Inc. C46 (82459)	45	4	2	3	5.0	84.4
964	Inc. 364 (C64)	33	4	2	2	3.5	87.9
968	Inc. 468 (US 75)	33	4	2	5	24.8	54.5
Y030	Inc. Y930	20	5	4	5	20.4	65.0
917	Inc. 417 (C17)	42	2	2	4	56.9	26.2
F80-37	Inc. E937 (C37)	38	4	2	3	0.3	97.4
F81-37	Inc. F80-37 (81101)	41	4	2	4	5.1	87.8
E137	Inc. F80-37	37	4	2	3	6.8	89.2
F78-36	Inc. F77-36 (78087)	36	4	2	4	0.9	88.9

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)

Variety	Powdery Mildew Score			Erwinia Reaction					
				Replication I			Replication II		
	8/12	8/18	8/29	No.	DI	% Resist.	No.	DI	% Resist.
H1	3.0	5.5	4.5	21	9.7	90.5 M	22	7.2	86.4 S
H2	3.0	5.5	6.0	22	22.6	77.3	19	9.3	84.2
H3	2.0	4.0	3.5	20	9.4	90.0	20	0.8	90.0
H4	2.0	4.0	4.0	25	14.5	84.0	23	26.7	47.8
H5	3.0	5.0	6.0	19	0.1	100.0	24	17.3	62.5
H6	3.0	5.5	7.0	21	23.8	61.9	23	3.4	95.7
H7	3.0	6.0	6.0	16	27.3	62.5	17	35.9	52.9
H8	2.0	4.5	6.0	21	7.1	90.5	24	5.9	79.2
H9	4.0	5.5	7.5	18	26.7	61.1	18	15.7	83.3
H10	2.0	5.0	6.0	16	26.6	62.5	22	31.6	50.0
H11	2.0	5.0	4.5	18	33.6	61.1	24	19.8	62.5
H12	2.0	5.5	7.0	18	8.0	88.9	17	16.8	70.6
US H10B	3.0	6.0	6.5	21	4.8	95.2	27	26.7	51.9
US H11	4.0	6.0	7.0	25	0.0	100.0	24	9.9	62.5
Y246H8	2.0	5.0	7.5	25	0.0	100.0	24	6.1	66.7
E140	2.0	5.5	6.5	22	89.3	9.1	23	98.3	0.0
2C0107	2.0	5.0	6.0	25	6.7	84.0	28	6.9	92.9
2C0104	2.0	5.0	5.5	23	11.0	73.9	29	9.4	86.2
2C0105	2.0	4.5	5.5	18	10.6	72.2	23	4.6	95.7
2C0106	2.0	5.0	5.5	20	9.5	70.0	26	3.5	88.5
2G5543	1.5	4.0	5.5	25	13.9	68.0	21	12.0	85.7
2G5545	1.0	3.5	5.0	22	11.4	77.3	24	23.0	66.7
2G5539	2.0	4.0	5.5	26	6.8	84.6	21	13.1	81.0
2G5540	2.0	4.5	5.5	18	6.0	88.9	19	16.4	78.9
2G5541	2.0	3.5	5.5	20	9.8	90.0	24	5.2	87.5
2C0114	2.0	4.5	5.5	24	4.8	87.5	23	8.1	82.6
US H11	3.0	4.5	7.0	21	5.4	85.7	25	3.4	92.0
OPEN-POLLINATED LINES									
E240	2.0	5.0	6.5	22	90.6	9.1	14	100.0	0.0
917	2.0	5.0	7.5	16	56.9	37.5	18	86.7	5.6
F82-36	2.0	5.5	8.0	21	1.6	90.5	23	8.6	87.0
F81-37	2.0	5.5	7.0	18	0.4	94.4	20	8.7	70.0
F82-46	3.0	4.5	4.5	22	18.5	77.3 S	25	5.0	88.0 M
964	3.0	5.5	5.5	22	4.6	90.9 M	12	25.1	75.0 S
968	3.0	6.0	6.0	24	27.5	45.8	11	51.6	45.5
Y030	4.0	6.5	8.0	21	15.3	76.2	12	47.4	50.0
917	5.0	6.0	8.0	20	92.7	0.0	3	97.7	0.0
F80-37	4.0	6.0	8.0	19	1.5	94.7	6	22.2	50.0
F81-37	4.0	6.5	7.5	18	6.0	83.3	8	13.8	75.0
E137	4.0	6.5	7.0	16	0.0	100.0	11	5.9	72.7
F78-36	5.0	7.0	8.0	21	5.3	90.5	23	2.4	91.3

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
F82-36	Inc. C36 (82421)	37	3	2	4	2.8	94.6
C35-1	PM res. release	30	3	4	3	0.2	100.0
C35-2	PM res. release	23	4	4	3	0.0	100.0
C35-1/2	PM res. release	32	4	2	2	2.2	90.6
E936	Inc. E736	34	3	2	4	1.0	94.1
E240	Inc. E640	33	3	2	-	90.3	9.1
Y042	YR-ER Y842 (C42)	37	3	2	2	10.6	83.8
Y139	YR-ER Y039	39	3	2	2	5.6	84.6
Y123	NB Y923	25	4	3	2	23.0	56.0
Y126	NB Y926	39	3	2	2	24.0	53.8
Y146	Inc. Y046	30	3	2	3	10.8	76.7
Y146	YR-ER Y046	37	2	2	3	10.1	75.7
F82-46	Inc. (C46)	36	4	2	2	17.5	72.2
Y246	Inc. Y146	28	4	2	2	13.5	78.6
Y141	Inc. Y041	42	2	2	2	4.4	88.1
Y141	YR-ER Y041	36	3	2	2	9.3	88.3
Y147	YR-ER Y947	35	2	2	2	1.1	85.7
Y148	YR-ER Y948	30	2	2	4	19.0	70.0
Y149	Inc. Y049	32	2	2	2	11.8	81.3
Y249	YR-ER Y049	37	2	2	2	4.1	86.5
Y152	Inc. Y052	35	3	2	2	17.0	68.6
Y252	YR-ER Y052	34	2	2	2	14.8	70.6
Y254	Inc. 1201-5	32	3	2	2	11.3	71.9
Y253 (3N)	Yugo 4N x 1201-5	34	2	2	2	38.9	50.0
2731	1206-13mmaa x A	35	4	3	3	30.7	57.1
F79-31	Inc. C31E2 (79427)	38	3	2	2	14.3	71.1
Y131	Inc. Y031	37	2	2	2	24.0	64.9
Y131	YR-ER Y031	43	2	2	2	16.1	74.4
Y231	Inc. Y131 (C31/4)	35	2	2	2	24.4	68.6
E240	ERR susc. check	38	3	2	-	85.7	7.9
SELF-FERTILE LINES							
0747	ER-YR 7747	42	3	2	3	6.3	83.3
1747	YR-ER 0747aa x A	40	2	2	4	6.2	82.5
0748	ER-YR 7748	43	2	2	5	16.0	74.4
1748	YR-ER 0748	45	2	2	3	16.5	82.2
2747	1747,8aa x A	46	2	2	3	11.5	84.8
Y254H53	1747,8aa x 1201-5	43	4	2	3	3.1	93.0
2218A	ER 1218-#'s	41	2	2	2	8.7	82.9
2219A	ER 1219-#'s	39	2	2	3	11.8	82.1
2220C1	ER 1220-#'s	35	3	2	2	27.2	57.1
2221A	ER 1221-#'s	37	3	2	2	14.2	81.1

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)

	Powdery Mildew Score			Erwinia Reaction					
				Replication I			Replication II		
Variety	8/12	8/18	8/29	No.	DI	% Resist.	No.	DI	% Resist.
F82-36	5.0	7.0	8.5	20	0.0	100.0	24	7.5	87.5
C35-1	2.0	5.5	5.0	13	0.0	100.0	20	3.3	85.0
C35-2	2.5	5.5	5.0	21	4.8	95.2	16	0.2	100.0
C35-1/2	2.0	5.0	5.0	14	0.0	100.0	24	0.5	95.8
E936	6.0	6.5	8.5	20	0.2	100.0	17	1.5	82.4
E240	5.0	5.5	--	23	98.9	0.0	21	99.7	0.0
Y042	3.0	5.0	5.5	25	3.9	96.0	22	16.7	68.2
Y139	1.0	3.5	3.5	27	9.9	85.2	25	11.8	80.0
Y123	2.0	4.5	4.0	20	8.9	80.0	20	12.2	80.0
Y126	1.0	3.0	4.5	22	4.3	95.5	24	17.8	75.0
Y146	2.0	4.5	5.0	18	16.7	66.7	21	9.2	90.5
Y146	1.0	3.0	4.0	19	5.4	94.7	25	5.6	84.0
F82-46	1.0	3.5	4.0	22	12.3	77.3	24	10.4	83.3
Y246	1.0	3.0	4.5	21	19.0	71.4	19	10.6	84.2
Y141	1.0	2.0	3.0	18	0.5	94.4	20	5.0	90.0
Y141	1.0	2.5	3.0	21	0.1	100.0	28	0.0	100.0
Y147	1.0	3.0	4.0	25	16.0	84.0	23	0.0	100.0
Y148	1.0	3.5	5.0	22	9.4	81.8	22	4.6	95.5
Y149	1.0	3.5	5.0	21	13.6	85.7	16	0.3	100.0
Y249	1.0	3.0	4.5	19	16.6	68.4	19	4.1	94.7
Y152	1.0	3.5	5.0	20	19.1	70.0	23	12.8	82.6
Y252	2.0	4.0	5.0	19	7.6	84.2	23	5.7	87.0
Y254	1.0	3.0	4.5	23	2.2	95.7	19	23.3	73.7
Y253 (3N)	2.0	4.0	4.0	23	13.6	82.6 S	20	2.9	90.0 M
2731	3.0	4.0	5.0	16	35.8	62.5 M	14	47.7	50.0 S
F79-31	4.0	4.5	5.5	17	30.6	58.8	12	11.2	75.0
Y131	3.0	4.5	5.0	19	35.0	47.4	22	26.7	63.6
Y131	3.0	4.5	4.5	19	13.3	78.9	24	6.0	91.7
Y231	2.0	4.5	4.5	18	10.4	83.3	18	19.1	72.2
E240	3.0	5.0	--	20	99.0	0.0	19	98.3	0.0
SELF-FERTILE LINES									
0747.	4.0	6.0	7.5	18	15.1	61.1	22	10.5	81.8
1747	3.0	6.0	7.0	18	26.1	66.7	24	3.9	95.8
0748	4.0	6.0	7.0	19	31.3	63.2	20	20.2	70.0
1748	3.0	5.5	6.5	21	33.9	61.9	23	29.0	60.9
2747	3.0	6.5	7.0	22	32.8	54.5	23	14.2	78.3
Y254H53	4.0	6.0	7.5	23	9.1	78.3	18	25.7	72.2
2218A	2.0	3.5	4.5	23	7.7	91.3	22	3.7	95.5
2219A	2.0	4.5	5.0	22	13.7	81.8	20	2.2	85.0
2220C1	4.0	5.0	6.0	22	28.8	63.6	22	40.0	45.5
2221A	3.0	5.0	6.0	22	9.2	90.9	22	25.1	68.2

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
2222A	ER 1222-#'s	36	3	2	2	11.2	83.3
2223-8	ER 1223-1228-#'s	34	3	2	3	15.3	70.6
F81-37	Inc. F80-37 (81101)	37	3	2	3	3.1	91.9
0740	9740aa x A	36	2	2	3	41.2	38.9
2741	YR-ER 0741 (A, aa)	31	3	2	2	19.1	61.3
2742	YR-ER 0742 (A, aa)	34	3	2	2	17.5	70.6
2744	YR-ER 0744 (A, aa)	35	3	2	4	12.8	68.6
2745	YR-ER 0745 (A, aa)	33	4	3	3	21.6	54.5
2790	1790aa x A	33	3	2	3	33.0	54.5
1790D	9790D-S_1 (SY)aa x A	39	3	2	4	15.2	71.8
1796	0796-1, -2aa x A	39	2	2	5	6.4	89.7
1796HO	0796-1, -2HO x 0796-1,2	42	3	2	5	21.2	69.0
2797	1757aa x 0792-8	44	2	2	4	16.5	56.8
2797P	Inc. 0792-8	35	4	4	3	20.1	48.6
F78-546H3	(78155)	32	3	2	5	7.9	71.9
E140	ERR susc. check	49	3	2	-	88.2	10.2
F82-546H3	(82460)	29	4	4	4	8.3	75.9
0755	9755aa x A	34	3	2	2	28.5	50.0
1755	YR-ER 9755 (A, aa)	37	3	2	2	16.9	67.6
2755	1755aa x A	31	3	2	2	19.1	67.7
2755HO	0755HO x 1755	30	3	2	2	32.0	46.7
2755D	9755-S_1 (SY)aa x A	28	4	2	2	49.7	35.7
2755E	9755-S_1 (% S)aa x A	30	3	2	2	52.8	33.3
1757	0755aa x A	30	4	3	2	47.6	43.3
2757	1757aa x A	24	4	3	3	33.9	50.0
2757HO	1757HO x 1757	26	4	3	2	37.1	38.5
1759	0755-#-#aa x A	26	4	4	2	51.3	34.6
E140	ERR susc. check	39	3	2	-	88.9	5.1
F82-36	Inc. C36 (82421)	29	4	3	3	4.3	79.3
2802A	Inc. 9755-S_1	33	4	2	2	22.4	57.6
2803A	Inc. T-O 1755-S_1	32	3	2	3	19.0	65.6
2804A	Inc. T-O 1757-S_1	23	5	5	3	50.2	43.5
1755-29	0755-29aa x A (C301)	25	5	4	4	44.0	32.0
F82-301	Inc. C301 (82423)	35	4	3	4	35.6	34.3
F82-301CMS	Inc. C301CMS (82422)	33	3	2	4	19.3	48.5
2805A	Inc. 9755-52 (C304)	37	4	2	2	74.4	13.5
2806A	Inc. 9755-82 (C305)	25	5	3	2	40.6	24.0
2807A	Inc. 9755-110 (C306)	30	4	3	0	63.2	16.7
2808A	Inc. 9755-119 (C307)	22	4	4	2	57.6	18.2
2809A	Inc. 9755-27 (C302)	3	6	6	-	0.0	100.0

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)

Variety	Powdery Mildew Score 8/12	8/18	8/29	Erwinia Reaction Replication I No.	DI	% Resist.	Replication II No.	DI	% Resist.
2222A	2.0	4.5	5.5	20	16.3	80.0	19	0.4	94.7
2223-8	3.0	5.0	6.0	21	10.4	76.2	20	5.0	95.0
F81-37	4.0	5.5	6.5	17	2.1	88.2	19	15.8	84.2
0740	3.0	4.5	6.0	25	17.1	72.0	22	8.8	90.9
2741	2.0	4.5	6.0	23	15.0	82.6	23	8.7	87.0
2742	2.0	2.5	3.0	20	5.0	90.0	21	8.3	90.5
2744	2.0	4.5	6.5	24	8.4	87.5	25	3.7	96.0
2745	3.0	5.0	6.0	20	15.4	75.0	23	13.8	82.6
2790	2.0	4.5	5.0	19	28.6	68.4	24	18.3	70.8
1790D	3.0	5.0	6.0	25	12.0	80.0	21	22.1	66.7
1796	3.0	5.5	7.0	15	15.1	73.3	16	16.3	81.3
1796HO	2.0	5.5	7.5	15	32.9	46.7	17	21.8	64.7
2797	1.0	3.5	6.5	25	17.6	72.0	24	17.8	70.8
2797P	1.0	5.5	5.5	14	20.9	78.6	23	14.5	65.2
F78-546H3	1.0	4.5	6.5	23	9.3	82.6	24	1.1	95.8
E140	4.0	6.0	--	21	90.1	4.8	22	99.7	0.0
F82-546H3	2.0	4.0	4.5	23	18.2	65.2	24	33.3	66.7
0755	2.0	4.0	4.5	23	37.1	56.5	19	15.1	78.9
1755	2.0	3.5	4.0	24	23.4	70.8	21	19.0	81.0
2755	2.0	3.0	4.0	21	17.5	81.0	18	16.9	77.8
2755HO	2.0	3.0	5.0	15	75.8	13.3	13	15.4	76.9
2755D	2.0	2.5	4.5	20	56.5	40.0	22	39.8	54.5
2755E	2.0	3.5	4.5	18	90.3	5.6	26	30.3	65.4
1757	2.0	5.5	6.0	17	62.7	35.3	25	23.8	76.0
2757	3.0	6.0	5.0	20	60.9	20.0	25	20.8	68.0
2757HO	3.0	5.5	5.5	19	41.4	57.9	21	32.5	57.1
1759	3.0	5.5	6.0	19	70.5	26.3	18	47.1	50.0
E140	3.0	5.0	7.0	25	94.9	4.0	15	79.6	13.3
F82-36	4.0	7.5	8.5	20	0.5	95.0	20	9.5	90.0
2802A	3.0	6.0	6.0	24	29.6	66.7	20	66.8	25.0
2803A	3.0	5.5	5.5	24	14.3	83.3	25	40.0	52.0
2804A	3.0	5.5	5.5	25	40.8	56.0	23	54.9	39.1
1755-29	3.0	5.5	6.0	19	36.2	63.2	19	35.7	63.2
F82-301	2.0	4.5	4.5	19	40.5	52.6	23	13.1	87.0
F82-301CMS	2.0	4.0	6.0	24	33.2	62.5	20	9.7	90.0
2805A	1.0	2.5	3.5	22	49.5	40.9	23	20.8	78.3
2806A	1.0	2.5	4.0	20	69.0	25.0	20	49.1	45.0
2807A	1.0	2.0	3.5	19	45.9	52.6	21	52.0	47.6
2808A	1.0	3.5	6.5	26	46.3	46.2	27	25.3	66.7
2809A	2.0	4.0	6.0	22	39.5	50.0	21	39.0	52.4

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TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-2 (Spence Field), 1 Rep

Variety	Description	No. Roots	Seedling Survival 7/4	Seedling Survival 7/14	P.M. Score 9/20	Erwinia Reaction DI	Erwinia Reaction % Resist.
2810A	Inc. 9755-35 (C303)	37	3	2	0	81.7	10.8
F82-546	Inc. C546 (82372)	9	5	6	5	0.9	88.9
F82-562	Inc. C562 (82196)	25	5	5	6	39.8	36.0
F82-562HO	Inc. C562CMS (82195)	42	4	2	5	26.4	50.0
9718	Inc. C718	36	4	2	4	27.7	33.3
3195CMS	CMS, 2N mm	31	4	2	4	5.9	83.9
NS-338	Chinese 1	43	2	1	2	23.9	60.5
NS-359	Chinese 2	40	2	1	3	29.6	57.5
F78-546	Inc. F70-546	22	5	5	4	12.0	63.6
1546	Inc. 0546	23	5	5	4	5.3	73.9
8563	Inc. F67-563	31	4	4	4	27.5	12.9
0755-10	Inc. 9755-10	22	5	4	0	66.4	13.6
0755-18	Inc. 9755-18	42	4	2	2	10.5	71.4
0755-34	Inc. 9755-34	32	4	3	3	43.4	37.5
0755-43	Inc. 9755-43	18	5	5	2	35.2	33.3
0755-77	Inc. 9755-77	5	5	6	-	45.0	40.0
0755-112	Inc. 9755-112	21	5	5	2	70.8	19.0
0755-125	Inc. 9755-125	34	5	4	0	72.6	23.5
0755-129	Inc. 9755-129	15	5	6	2	33.3	46.7
0755-133	Inc. 9755-133	35	4	3	2	35.3	37.1
1214	0758-1HL15®	36	4	2	2	21.6	66.7
1215	ER 0758-1HL15	34	4	2	3	36.6	41.2
1216	0546HL15®	36	4	2	3	17.5	52.8
1217	ER 0546HL15	33	4	2	3	23.2	51.5
F78-546H3	(78155)	32	3	2	4	2.6	87.5
1546H72	C718HO x 0546	37	2	2	4	5.7	75.7
1546HL3	757CMS x 0546	32	2	2	3	12.0	75.0
1546HL5	C301CMS x 0546	32	3	2	4	6.8	81.3
1755-29H72	C718HO x 0755-29	27	4	4	6	30.4	33.3
E140	ERR susc. check	32	3	3	-	89.9	3.1
Yugo-1	4N MM (E)	31	2	2	2	32.3	58.1
Yugo-2	4N MM (N)	27	4	4	3	44.4	44.4
Yugo-3	4N MM (N)	36	2	3	2	16.3	83.3
Yugo-4	4N MM (NZ)	34	2	2	2	33.9	64.7
Yugo-5	4N MM (E)	29	3	4	2	23.1	69.0
Yugo-6	4N MM (NZ)	24	3	4	2	37.3	58.3
Yugo-7	4N MM (N)	31	3	3	2	23.2	61.3
Yugo-8	4N MM (Z)	22	3	4	0	34.9	54.5
Yugo-9	4N MM (ZZ)	17	3	5	2	64.0	29.4
Yugo-10	4N MM (Z)	26	3	3	2	27.6	57.7

TEST 2183. POWDERY MILDEW AND ERWINIA ROOT ROT OBSERVATION TESTS, SALINAS, CA, 1983 (Continued)

Test 2183-1 (Salinas, 2 Reps)

Variety	Powdery Mildew Score			Erwinia Reaction					
				Replication I			Replication II		
	8/12	8/18	8/29	No.	DI	% Resist.	No.	DI	% Resist.
2810A	1.0	2.0	3.0	19	31.6	68.4	23	65.7	26.1
F82-546	2.0	4.5	6.5	21	37.8	61.9	22	9.5	86.4
F82-562	1.0	3.5	6.0	20	30.0	65.0	22	20.8	68.2
F82-562HO	2.0	4.5	7.0	21	6.0	90.5	20	33.1	60.0
9718	1.0	4.5	4.0	13	84.6	15.4	18	66.3	27.8
3195CMS	1.0	5.0	6.5	20	25.0	75.0	24	13.9	75.0
NS-338	1.0	3.0	3.5	19	8.1	89.5	22	31.0	63.6
NS-359	2.0	4.5	3.5	18	10.7	S 88.9	21	18.7	M 81.0
F78-546	3.0	4.5	6.0	17	5.5	M 94.1	16	35.9	S 62.5
1546	3.0	5.0	6.5	18	0.1	100.0	14	28.6	71.4
8563	3.0	4.5	7.5	17	29.0	58.8	9	25.0	66.7
0755-10	1.0	1.5	3.5	20	59.1	35.0	20	29.7	70.0
0755-18	1.0	2.0	4.0	19	26.4	68.4	19	11.0	84.2
0755-34	1.0	2.5	3.0	22	21.8	72.7	20	23.8	60.0
0755-43	1.0	2.5	3.0	21	49.3	42.9	26	61.8	34.6
0755-77	1.0	2.0	2.0	20	22.5	75.0	20	20.1	75.0
0755-112	1.0	2.0	4.5	24	60.3	37.5	25	51.2	48.0
0755-125	1.0	2.0	4.5	18	90.9	5.6	25	78.2	20.0
0755-129	1.0	2.5	4.5	22	50.0	45.5	20	39.0	55.0
0755-133	0.0	2.0	3.0	21	24.8	66.7	20	27.3	70.0
1214	1.0	2.5	5.0	19	31.6	63.2	19	41.4	36.8
1215	1.0	2.5	4.0	22	43.4	54.5	29	26.2	62.1
1216	1.0	2.5	4.5	22	4.9	90.9	18	10.2	77.8
1217	1.0	3.5	5.0	24	11.9	87.5	22	14.8	77.3
F78-546H3	2.0	4.5	5.5	23	10.9	87.0	27	5.6	92.6
1546H72	2.0	5.5	7.5	22	12.2	86.4	17	5.9	94.1
1546HL3	2.5	5.0	6.5	21	9.3	85.7	25	4.0	96.0
1546HL5	2.0	5.5	6.5	23	12.6	82.6	26	3.2	92.3
1755-29H72	3.0	5.5	7.5	17	38.8	58.8	23	24.2	69.6
E140	3.0	5.0	7.5	21	96.5	0.0	22	99.4	0.0
Yugo-1	1.0	3.0	4.0	18	24.7	66.7	20	16.8	70.0
Yugo-2	1.0	2.5	5.0	17	32.4	47.1	15	10.0	86.7
Yugo-3	1.0	2.5	5.0	16	35.5	56.3	21	33.0	61.9
Yugo-4	1.0	3.5	6.0	23	32.7	56.5	22	27.6	59.1
Yugo-5	2.0	3.5	5.0	17	34.5	47.1	17	14.4	76.5
Yugo-6	2.0	3.5	5.0	10	61.8	30.0	18	33.1	61.1
Yugo-7	1.0	3.5	5.0	9	27.9	55.6	20	34.0	55.0
Yugo-8	0.0	3.0	5.0	11	13.6	81.8	12	36.2	41.7
Yugo-9	0.0	3.5	5.0	11	27.3	63.6	13	44.2	38.5
Yugo-10	2.0	4.0	5.0	7	14.3	S 85.7	15	47.9	M 46.7

TEST 1883. PERFORMANCE EVALUATION OF MONOGERM GERMPLASM, SALINAS, CA, 1983

8 entries x 8 reps, RCB[1]/
1-row plots, 61 ft. long

Planted: May 5, 1983
Harvested: October 27, 1983

Variety	Description[4]/	Acre Yield[2]/ Sugar Adj. Lbs	Beets Adj. Tons	Sucrose %	Root Rot %	Beets/ 100' Number	Miss. Feet Row Ft	Non Sucrose SS %	Raw J. App. Purity %	Sugar Yd. Not Adj.[3]/ Lbs/A
2797	1757,9aa x 0792-8	8,692	28.33	15.38	0.9	79	4.9	2.9	84.0	8,009
2755	1755(Iso.)aa x A	7,845	24.97	15.75	0.8	73	8.1	3.0	84.1	6,836
2790	1790(Iso.)aa x A	7,596	24.77	15.31	0.3	76	8.4	3.4	81.9	6,571
1755-29H72	C718HO x C301	7,320	26.23	13.98	0.8	48	22.0	3.0	82.2	4,640
1796	0796-1,2aa x A	7,254	23.88	15.19	0.3	72	9.6	2.9	83.8	6,098
F82-546H3	(82460) C562CMS x C546	7,013	22.73	15.50	0.4	62	13.1	3.0	83.6	5,531
2741-5	YR-ER 0741,2,4,5 (A, aa)	6,562	20.18	16.27	0.0	71	10.6	3.4	82.7	5,439
2731	1206-13mmaa x A	6,329	20.64	15.38	1.6	59	14.4	3.3	82.3	4,829
Mean		7,326	23.97	15.34	0.6	68	11.4	3.12	83.1	5,994
LSD (.05)		636	2.11	0.83	0.0NS	12	5.2	0.26	1.5	852
C. V. (%)		8.6	8.80	5.40	228.9	17.6	45.3	8.40	1.8	14.2
F value		11.1**	13.7**	4.9**	1.0NS	6.1**	8.2**	4.6**	2.8*	14.0**

1/ See footnote for test 1683. Several of these monogerm populations were considerably more susceptible to the severe seedling condition than were the hybrids or O.P. lines.

2/ Beet yield and sugar yield adjusted for missing feet of row.

3/ Sugar yield not adjusted for missing feet.

4/ 2797 = composite cross to combine mm, S^f populations 757, 759, 792, 793, 794, 795, and 798 that had been selected for disease resistance (VY, ERR, PM). 2741-5 = composite cross of mm, S^f populations 741, 742, 744, and 745. 2731 = composite cross. 2755, 2790, and 1796 = mm, S^f, A:aa populations selected for disease resistance (VY, ERR, PM).

SUGARBEET RESEARCH

1983 Report

Section B

Crops Research Laboratory, Logan, Utah

Dr. R. E. Wyse, Plant Physiologist
Dr. Donald Briskin, Plant Physiologist

Cooperation:

Utah Agricultural Experiment Station

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 64).

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I. REGULATION OF SUCROSE ACCUMULATION: A NEW HYPOTHESIS by R. E. Wyse B2

REGULATION OF SUCROSE ACCUMULATION: A NEW HYPOTHESIS

Roger Wyse

The factors controlling sucrose accumulation in sugarbeet are far from clear, but apparently involve a complex interaction of physiological, biochemical, and morphological factors. Strong genetic differences exist between cultivars in their potential for sucrose storage. This genetic potential, however, is greatly modulated by environmental conditions. The only factors which consistently relate both genetic and environmental variables to sucrose content are cell size and vascular density in the taproot. These two factors correlate closely with sucrose content across a range of both genetic and environmental conditions (Table 1).

Table 1. Relationship Between Cell Size, Ring Density and Sucrose Content

Genotype	Cell Size	Ring Density	Sucrose	
	$cm^3 \times 10^{-8}$	mm/ring	% FW	% DW
Blanca	129 ± 12	9.4 ± 1.0	9.4 ± 1.2	67 ± 8
GW D-2	80 ± 5	5.3 ± 0.2	16.3 ± 0.4	77 ± 4
L53 X L19	83 ± 6	4.7 ± 0.2	17.6 ± 1.4	76 ± 3

The inverse relationship between cell size and sucrose content may also explain the inverse relationship commonly found between yield and sucrose content (Doney, et al. 1981). However, factors other than cell size must be involved. When the cell size of a fodder beet is experimentally reduced by growing the plant at high populations in the field, the sucrose content increases but does not reach the level of a sugar-type beet even though the cell size of both cultivars is the same (Wyse, 1981). Therefore, factors other than cell size and vascular density must be involved.

We have attempted to determine if differences in sugar content can be explained by the differential capacity of cultivars to transport and store sucrose in the vacuole. Using conventional methods for determining sucrose loading into the vacuole of tissue discs (Saftner, et al. 1983) an inverse relationship between transport rates and sucrose content was observed (Table 2).

Table 2. Sucrose Uptake by Taproot Discs Isolated from cultivars with diverse capacity for sucrose storage in the vacuole.

	nmols/2 hr/20 discs
Blanca	136
GW D-2	90
L53 X L19	56

Temp, 25 C, .005 M sucrose

Sucrose uptake into the storage vacuole was reduced in sugar types relative to the low sugar fodder type. However, the results are probably confounded by internal sucrose content. For example, sugar types must load sucrose against a higher concentration gradient than fodder types.

This series of results suggest that a new hypothesis must be posed before further progress can be made toward understanding the mechanism limiting sucrose accumulation.

New Hypothesis: The low molecular weight and high solubility of sucrose make it an osmotically-active compound. The sugarbeet stores sucrose in the vacuole to concentrations approaching 800 mM. This is equivalent to 19 bars of osmotic pressure. Since sucrose is not uniformly distributed within the taproot tissue or even within a single cell, osmotic adjustment must occur if the tissue is to maintain uniform water potential. The sucrose content of cells near the vascular bundles is higher than that of cells in the interzone

Table 3. Osmotic Concentration in the Vascular and Parenchymal Tissue of Three cultivars with Diverse Capacity for Sucrose Storage

	Vascular	Parenchyma
	mmol L^{-1}	
Osmolality		
L53 X L19	658	676
Blanca	389	352
GW D-2	622	593

region (Figure 1). However, the osmotic concentration within the cells of the two regions are not significantly different (Table 3). Therefore, osmoregulation has occurred. Uniform osmotic concentrations are achieved by storage of amino acids, potassium, and reducing sugars instead of sucrose in the interzone parenchymal cells (Figure 1).

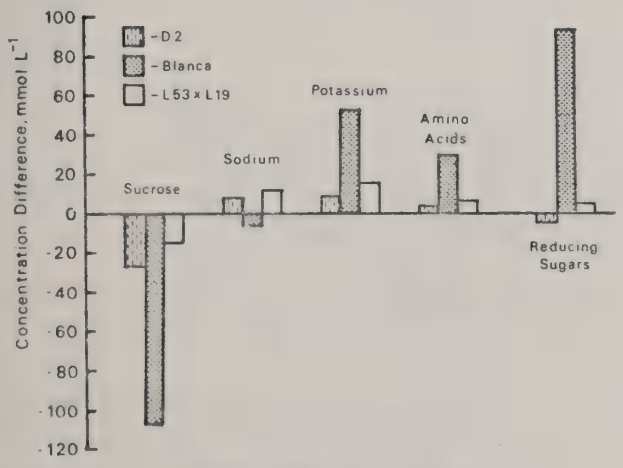

Figure 1. Differences in solute concentration between vascular and interzone parenchymal cells. Values above zero indicate higher concentrations in the interzone region.

An additional problem that must be resolved during the growing season is that of turgor adjustment. As sucrose accumulates during the growing season, the osmotic solute level increases from 200 to approximately 800 mM (5-19 bars). However, the turgor pressure in a mature sugarbeet root cell measured directly with a pressure probe is only 3-5 bars. (R. Wyse and Wyn Jones in preparation). Therefore, the cells somehow regulated turgor from 15-19 down to 3-5 bars. The only way a cell can turgor regulate is by reducing the solute gradient from the inside to the outside of the cell. This can be achieved by either reducing the osmotically active concentration in the cell (increasing the mean molecular

weight) or increasing the concentration of solutes in the cell wall. There is no evidence that the mean molecular weight of the cellular contents of a taproot cell change during the growing season; therefore, it is most likely that turgor regulation occurs as an increase in cell wall osmotic concentration in the sugarbeet root.

Turgor Effects: Turgor effects on cellular function are poorly understood but may have important implications in sucrose storage. Sucrose uptake by sugarbeet taproot discs show biphasic kinetics (Figure 2).

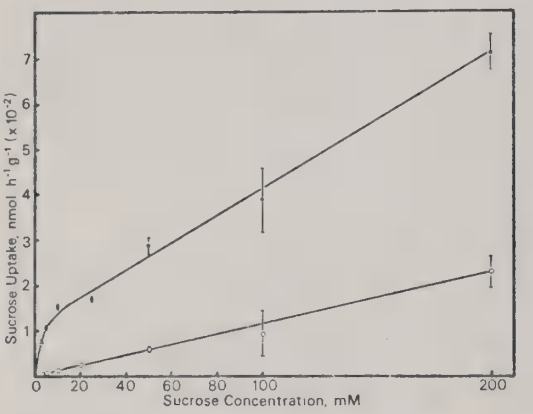

Figure 2. Active and passive sucrose uptake by taproot tissue discs.
(●) - Active (O) - Passive

Active uptake, at low external concentrations, is typical of saturation-type kinetics suggesting carrier-mediated transport. However, at concentrations above 20 mM active uptake increases linearly with increasing concentration. The mechanism of the linear component is unknown.

Our research this past year shows that the mechanism operating at low external concentration is regulated by cell turgor pressure. Tissue discs equilibrated in water (cell wall solutes removed, therefore, high turgor) show no evidence of a saturating component (Figure 3). However, discs equilibrated in 200 or 400 mM mannitol exhibit saturation kinetics. Therefore, high-cell turgor (water-equilibrated tissue) inhibits the saturation component. Fructose and glucose show saturation-type kinetics, and but their uptake systems are not inhibited by high turgor (Figure 4). Therefore, only the sucrose transport system is sensitive to turgor inhibition.

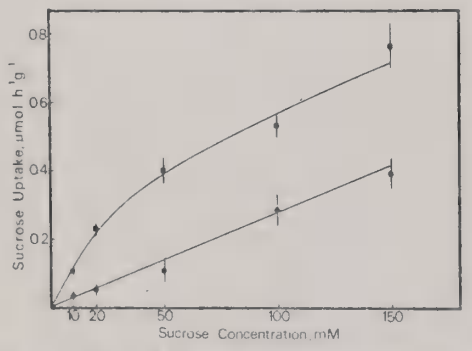

Figure 3. Effect of external osmoticum on the kinetics of sucrose uptake in taproot tissue discs.
(■) - 400 mM mannitol
(●) - water control

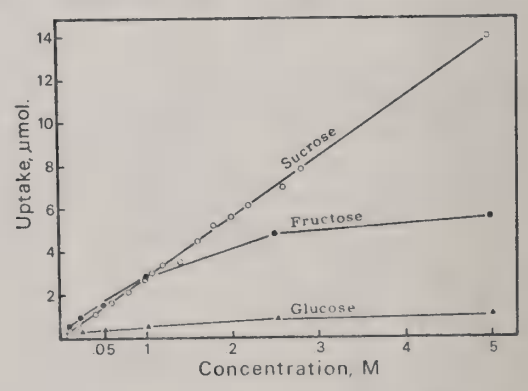

Figure 4. Kinetics of sugar uptake in sugarbeet taproot tissue discs equilibrated in distilled water.

Cell turgor has important effects not only on cell expension and turgidity but also on sucrose transport into the vacuole. Thus, I am proposing that cultivars with the ability to turgor regulation the cell wall are those with the capacity to store high levels of sucrose. Although the evidence points to future research in this direction, the hypothesis still needs to be proven.

References:

1. Doney, D. L., R. E. Wyse and J. C. Theurer. 1981. The relationship between cell size, yield and sucrose concentration of the sugarbeet root. Canadian J. of Plant Sci. 61:447-453.

2. Saftner, Robert A., Jaleh Daie and Roger E. Wyse. 1983. Sucrose uptake and compartmentation in sugarbeet taproot tissue. Plant Physiol. 72:1-6.

SUGARBEET RESEARCH

1983 Report

Section C

Crops Research Laboratory, Agricultural Research Service
U.S. Department of Agriculture, Fort Collins, Colorado

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Dr. S. S. Martin, Plant Physiologist
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This research was supported in part by funds provided through the Beet Sugar Development Foundation (Projects 20, 25, 53, 75, 76 and 81).

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Self Incompatibility and Seed Production by G. A. Smith and M. C. G. Middelberg C32

ABSTRACTS OF PAPERS PUBLISHED OR APPROVED FOR PUBLICATION AND GERMPLASM RELEASES AND REGISTRATIONS 1983

HECKER, R. J. and R. H. HELMERICK. Sugarbeet breeding in the United States. Book chapter in: Plant Breeding Progress Reviews. Russell, G. E. (Ed.). Butterworth, London. Accepted June 6, 1983.

This review chapter provides an update of sugarbeet breeding in the U.S. Current U.S. breeding methods, from source populations to finished hybrids, are described. Methods for development of parental components of hybrids are emphasized.

HECKER, R. J. and E. G. RUPPEL. 1983. Registration of FC 711 sugarbeet germplasm. Crop Sci. 23:601-602.

FC 711 (Reg. No. GP 87) was developed as a source of resistance to root rot caused by Rhizoctonia solani. This germplasm is heterogeneous, diploid, multigerm, pollen fertile, self sterile, and easy bolting. It originated from two heterogeneous Japanese breeding lines. It was developed following four cycles of mass and recurrent selection for resistance. The genetic diversity of FC 711 provides the potential for breeders to develop high combining resistant pollinators for hybridization with currently used monogerm male sterile lines.

HECKER, R. J. and E. G. RUPPEL. Release of sugarbeet germplasms FC 701/6, FC 702/7, and FC 705/1. Officially released 12/15/83.

These three germplasms are resistant to root rot caused by Rhizoctonia solani, multigerm pollen fertile, pseudo self fertile, diploid, and heterogeneous. These germplasms resulted from seven to nine cycles of selection for resistance. All three germplasms have exhibited good general combining ability for sucrose yield. They were released for use as pollinators, or as a source for development of pollinators, in the breeding of rhizoctonia-resistant hybrid varieties by sugarbeet breeders.

SMITH, G. A. 1984. Sugar crops and their utilization. Book Chapter in: CRC Handbook, Plant Science in Agriculture. Christie,;B. R. (Ed.). CRC Press, Boca Raton, Florida. Accepted Nov. 29, 1983.

The chapter describes the major sweetener crops, sugarbeet, sugarcane, corn, sugar maple and sweet sorghum. Products and by-products, along with U. S. and world production and consumption trends, are presented.

SKARACIS, G. N. and G. A. SMITH. 1984. Prediction of three-way top cross sugarbeet hybrid performance. Crop Sci. 24. Accepted Aug. 3, 1983.

A fixed set of inbred and pollinator diploid sugarbeet (Beta vulgaris L.) lines was used to synthesize all possible inbred x inbred, and inbred x pollinator single crosses, as well as all possible (inbred x inbred) x pollinator three-way top crosses. Parental lines, and single and three-way cross hybrids were grown in 1980 and 1981. The primary objective of this study was to develop and evaluate various methods to predict the performance of three-

way top cross hybrids and, secondarily, to assess the relative importance of different types of gene effects involved in the expression of root yield, sucrose content, and juice purity in the set of lines used. Predictions, based on the mean of the nonparental single crosses, involved in each three-way top cross were sufficiently reliable and proved equally good or better than predictions by other methods investigated. An inbred x pollinator factorial crossing system necessary for this approach also would be compatible with standard sugarbeet breeding procedures. Dominance and additive gene effects proved most important for root yield. Sucrose content and juice purity were controlled only by additive effects. No evidence for significant epistatic effects was found for any of the traits studied.

Papers Published Since the Previous Sugarbeet Research Report

RUPPEL, E. G., R. BAKER, G. E. HARMAN, J. P. HUBBARD, R. J. HECKER, and I. CHET. 1983. Field tests of Trichoderma harzianum as a biocontrol agent of seedling disease in several crops and rhizoctonia root rot of sugar beet. Crop Prot. 2:399-408.

RUPPEL, E. G., R. J. HECKER, and E. E. SCHWEIZER. 1982. Rhizoctonia root rot of sugarbeet unaffected by herbicides. J. Am. Soc. Sugar Beet Technol. 21:203-209.

SMITH, G. A. 1983. Herbicide resistance in sugarbeets. Agricultural Research. 5 (May):16.

SMITH, G. A. 1983. Sugarbeet Advances. Agricell Report. 1 (Sept.):21.

SMITH, G. A. 1983. Sugarbeets may hold key to herbicide resistance. Agrichemical Age. 11(Oct.-Nov.):17.

SMITH, G. A. and E. E. SCHWEIZER. 1983. Cultivar x herbicide interaction in sugarbeet. Crop Sci. 23:325-328.

RESEARCH ON RHIZOCTONIA ROOT ROT RESISTANCE AND GERMPLASM DEVELOPMENT

(BSDF Project 20B)

1983 Rhizoctonia Field Research.--R. J. Hecker and E. G. Ruppel.

The disease research projects supported by the BSDF were conducted on the Colorado State University South Farm in 1983. This is the second year that our disease research has been at this location. It has proven to be an ideal site for the research. We are pleased to be involved in this three-way cooperative

research involving the BSDF, Colorado State University, and ARS.

The 1983 rhizoctonia root rot experiments were conducted in an area of the farm that had been fallow in 1982, preceded by two years of corn. Weeds, insects, and other diseases were not a problem in the area. All the experimental plots were one row, 6.1 m (20 ft) long, and 56 cm (22 in) apart, except the plots for evaluation of contributed lines which were 4.3 m (14 ft) long. All the experiments were planted May 10, except the biocontrol experiment which was planted April 28. The experiments were thinned around June 22. Dry, ground barley-grain inoculum of Rhizoctonia solani (R-9) was broadcast in a band over each row with a tractor-mounted four-row granule applicator. The inoculum rate was 1.9 g/m of row in a split application (opposite direction of travel for each application). Intermittent overhead irrigation was used to moisten and activate the inoculum.

All roots in the experiments were lifted between September 8 and 20 and individually rated for extent of root rot. Disease index (DI) ratings were made on a scale of 0 to 7 (0 = no evidence of rot; 7 = plant dead and extensively decomposed). The percentage of healthy roots were those with index ratings of 0 and 1, those roots having no or only small arrested lesions. Those roots sufficiently sound to be recovered in a commercial harvest (classes 0 through 3) also were analyzed as a class. The epiphytotic of root rot in our 1983 rhizoctonia experiments was moderately severe and optimum for evaluations of our more resistant germplasm developments, but too severe to adequately differentiate between genotypes with relatively modest levels of rhizoctonia resistance.

The succeeding reports in this section on BSDF Project 20B describe individual experiments in our 1983 rhizoctonia root rot research project.

Evaluation of Contributed Lines.--E. G. Ruppel and R. J. Hecker.

Separate randomized complete block designs with five replicates were used to evaluate 57 contributed lines from four BSDF-member companies. Rhizoctonia-resistant line FC 703 and highly susceptible FC 901 were included as controls in each test. Results of each contributor's test were statistically analyzed and sent to company breeders, thus, they will not be reproduced here. The mean disease indexes for FC 703 and FC 901 across all tests were 2.8 and 5.9 (scale of 0 to 7), respectively. Percent healthy means were 29 and 1%, whereas % roots in classes 0 through 3 were 64 and 8%, respectively.

Resistance Evaluations of Germplasms from the Rhizoctonia Root Rot Resistance Development Project.-- R. J. Hecker and E. G. Ruppel.

Reports we have received during 1983 from industry, grower, and other sources indicate that sugarbeet crop losses due to rhizoctonia root rot continue to occur, and that the problem seems to be increasing in the northwest, Montana, and perhaps other areas. The beet-seed industry, through their breeding efforts and through the BSDF, is working toward the reduction of this loss through breeding efforts and participation and support of programs designed to develop germplasms resistant to this rot-causing fungus. In addition to cultural

practices, genetic resistance remains the best potential method for control of rhizoctonia root rot. The genetic resistance of germplasms developed in our program at Ft. Collins are, to our knowledge, resistant whenever exposed to AG-2 root-rotting strains of rhizoctonia. Evidence from our research continues to indicate that the resistance we have accumulated is multigenic, horizontal, and genetically additive.

The 1982 report to the BSDF by C. L. Schneider, ARS-USDA, E. Lansing, indicates that a new chemical control material, Bay NTN 19701 (pencycuron, proposed name) applied as a spray at 1 to 2 lbs/acre on Rhizoctonia-inoculated plants may provide significant protection against the disease. This appears to be the most promising chemical control detected in their fungicide testing program. Even if the efficacy of this material is demonstrated to be good as a Rhizoctonia control, it would be several years before it could be labeled for useage on sugarbeet.

Although the development of germplasms with increasing levels of resistance has been slow, there exists a continuing need for this effort. In our germplasm development effort, we are continuing to increase gradually the level of resistance. These germplasms are being released to the industry breeders as rapidly as practical. At the same time we are investigating and incorporating new potential sources of resistance. However, the incorporation of our resistant germplasm into acceptable commercial varieties requires a significant breeding effort by the private breeders, and achievement of the highest levels of resistance will undoubtedly require that the genes for resistance be incorporated into both the pollinator and male sterile parents used to make the commercial hybrids. Direct use as pollinators of resistant germplasms that we have released may be possible. However, combining ability has not been emphasized in our resistance breeding program. A posistive dosage effect for resistance due to an additional genome contributed from a resistant tetraploid pollinator should enhance the level of resistance in hybrids compared with hybrids involving an equivalent diploid resistant pollinator.

Three resistant germplasms (FC 701/6, FC 702/7, FC 705/1) were released to BSDF members in 1983. These are lines that showed relatively good general combining ability for sucrose production when tested on a common set of male-sterile testers. These are all multigerm non-type 0, self sterile, relatively easy bolting lines. These germplasms all originated from obsolete open-pollinated varieties adapted to the high plains region of the United States.

The results of our 1983 resistance evaluation of various multigerm germplasms in process of development are listed in Table 1. Many of these germplasms already have been released, and others are release candidates for the future. The most resistant among these germplasms represents considerable improvement from resistant check FC 703, which had been our most resistant germplasm less than a decade ago. Hence, progress toward improvement of resistance continues. Entry 341, which is a selection for resistance from a pool of USSR multigerm varieties, represents rather rapid development of a significant amount of resistance. This pool of USSR multigerms was classed as susceptible when our resistance selection effort was commenced.

Table 1. Means of multigerm resistant lines for disease index (DI), % healthy roots, and % roots rated 0 to 3 (Exp. 1R, 83).

Entry	Description	DI	% healthy roots	% rated 0 to 3
318	FC 709	1.5	65	95
334	FC 703/5	1.6	67	93
316	FC 705/1	1.6	66	94
333	FC 712	1.7	63	87
344	FC 707	1.8	56	88
343	FC 707/2	1.9	60	92
314	FC 705/2	1.9	59	88
319	FC 702/6	2.0	49	85
313	FC 710	2.1	45	89
339	FC 703/4	2.1	48	83
341	Resist. sel. from USSR MM's	2.2	45	85
337	3rd cy RL-damp-off sel	2.3	43	79
320	FC 702/7	2.3	48	77
346	FC 711	2.5	29	82
340	Resist. sel from (FC 703 X high suc. lines)	2.7	32	68
349	Transgress. segs. from (Rh. lines X FC 704)	2.7	34	72
325	FC 703 (4x)	2.8	33	71
356	HH 32	3.9	16	38
367	RR-34-6; Resist. from Japan	4.2	7	36
353	FC 703; resistant check	2.9	36	59
312	FC 901; susceptible check	5.2	6	21
	LSD (.05)	1.0	14	15

The monogerm resistant germplasms (or segregating for monogerm) are shown in Table 2.

Table 2. Means of monogerm resistant lines for disease index (DI), % healthy roots, and % roots rated 0 to 3 (Exp. 1R, 83).

Entry	Description	DI	% healthy roots	% rated 0 to 3
371	Syn. 2 from SP 5831-0	2.0	61	81
335	Syn. from 24 S_1's	2.1	54	86
355	FC 708 CMS	2.1	44	83
354	FC 708	2.5	37	75
351	Resist. type 0 line	3.0	25	75
327	Resist. sel. from (FC 708 X 3 LSR's)	3.1	26	66
331	SP80320-02 X FC 708	3.1	29	54
321	Resist. type 0 line	3.2	36	62
332	SP75576-01 X FC 708	3.4	16	54
366	FC 505 CMS	3.6	22	51
328	CMS resist. sel. from (FC 708 X 3 LSR's)	3.7	32	74
370	TK-84 CMS; Japanese resist. line	4.1	20	42
361	FC 505 CMS X SP6323-0	4.3	9	30
365	SP6123-0	4.6	11	25
364	SP6123-01 (CMS)	4.6	4	22
369	TK-84; 0-type; Japanese resist. line	4.8	11	21
360	SP6323-01 (CMS)	5.4	5	16
359	SP6323-0	5.6	2	16
336	Resist. sel. from USSR mm's	5.9	1	6
353	FC 703; resistant check	2.9	36	59
312	FC 901; susceptible check	5.2	6	21
	LSD (.05)	1.0	14	15

FC 708 (released several years ago) remains our most resistant monogerm type 0 and CMS germplasm. We are in the process of reindexing FC 708 for type 0, and in the future will have an improved version of this line available. FC 505 CMS, with a DI of 3.6, demonstrated relatively high resistance even though it has never been selected for rhizoctonia resistance. It is a leaf spot resistant monogerm released to the BSDF in 1965. SP 6123-0 and its CMS (entries 365 and 364, respectively) were included in the test, because hybrids in which it was involved in the past have shown modest levels of rhizoctonia resistance.

The autotetraploid (4x) of FC 708 and FC 708 CMS is still in the process of seed increase and, hopefully, will be available for release in the near future.

In order to get a preliminary combining ability assessment of germplasms from our resistance development project, we have generated experimental hybrids

between our resistant germplasms and a set of monogerm male-sterile testers. The rhizoctonia root rot evaluation and disease test of productivity are reported in subsequent sections of this report. The most promising resistant parental germplasms ultimately will be released.

Combining Ability Test for Sucrose Yield of Rhizoctonia Resistant Pollinators.--R. J. Hecker.

The development of germplasms resistant to root rotting strains of Rhizoctonia solani is a significant part of BSDF Project 20. Since the inception of this project, 24 germplasms have been released to BSDF member companies. The first of these releases is only moderately resistant compared to our most recent resistant germplasms. The majority of the releases have been multigerm diploids for potential use as pollinators. Each has had preliminary testing for general combining ability (GCA) of sucrose yield components by having been used as a pollinator on a common set of male sterile testers. The resistant pollinators so tested in a disease free nursery in 1983 are listed in Table 1 along with the means of the set of hybrids in which each pollinator was involved, except that the disease indices (DI) in Table 1 are for the pollinators per se from a separate inoculated test.

Table 1. General combining ability of Rhizoctonia-resistant pollinators as measured by means of a set of hybrids between these pollinators and a common set of CMS's (Ex.1, 83); disease indices (DI) are for pollinators per se in an inoculated field test (Ex. 1R, 83).

Resistant pollinator	Gross sucrose (T/A)	Root yield (T/A)	Sucrose (%)	DI
FC 703/5	2.96	22.6	13.2	1.6
FC 703(4x)	2.95	22.5	13.1	2.8
FC 712	2.93	22.2	13.4	1.7
FC 703/4	2.92	21.4	13.7	2.1
FC 703	2.81	20.9	13.6	2.8
Syn. Rh. sources	2.76	21.4	12.9	2.2
Rh. damp-off sel.	2.63	20.5	13.1	2.3

The most promising pollinators from the standpoint of GCA for sucrose production appear to be FC 703/5, FC 703(4x), FC 712, and FC 703/4. Of these FC 703(4x) and FC 703/4 have been released previously, whereas FC 703/5 and FC 712 are release candidates in 1984. These latter two are most promising for resistance, with DI's of 1.6 and 1.7, respectively. For purposes of comparison the DI's of HH 32 (moderately resistant commercial hybrid) and Mono Hy D2 (susceptible commercial hybrid) were 4.0 and 6.2, respectively. Hybrids of susceptible CMS's x FC 703/5 or FC 712 could be expected to have DI's of 3 to 4 based on our experience that resistance is slightly dominant or intermediate.

Twenty of the most superior experimental hybrids in this combining ability test are listed in Table 2. These are hybrids that apparently have relatively good specific combining ability (SCA). None of these hybrids had significantly greater gross sucrose than the control (Mono Hy D2). However, in a search for high SCA the set of 10 CMS testers used in this experiment is very small. More extensive hybridizations by private breeders, using their best CMS's with some of these pollinators, may reveal a few uniquely productive hybrids that also would have resistance inherited from the pollinator.

Table 2. Specific superior experimental hybrids in the 1983 disease-free combining ability test (Ex. 1, 83) of hybrids involving Rhizoctonia resistant parents.

Entry No.	Hybrid	Gross sucrose	Root yield	Sucrose
		(T/A)	(T/A)	(%)
852	[(FC505 CMS X 546)X USSR mm T.O.]X FC703/4	3.37	25.2	13.6
803	[(662119s1 CMS X 562)X FC708]X FC703(4x)	3.26	24.1	13.6
871	(662119s1 CMS X 562)X FC703/5	3.20	23.9	13.4
830	[(562 CMS X 546)X USSR mm T.O.]X FC703/5	3.15	25.6	12.4
864	[(FC504 CMS X 502/2)X 662119s1]X FC703/5	3.15	23.1	13.6
801	(FC604 CMS X Polish PI 372277)X FC703(4)	3.12	22.8	13.6
828	(642027s1 CMS X 662119s1)X FC703/5	3.11	23.2	13.5
825	[(662119s1 CMS X 562)X FC708]X FC712	3.10	23.7	13.2
840	(1861 CMS X 12166)X Syn. Rh. sources	3.10	22.9	13.5
867	[(652016s1 CMS X 662119s1)X FC506]X FC703/5	3.04	23.1	13.2
823	(642027s1 CMS X 662119s1)X FC712	3.02	23.3	13.1
841	(642027s1 CMS X 662119s1)X Syn.Rh. sources	2.99	23.2	12.9
809	((FC708 CMS X USSR mm T.O.)X FC703(4x)	2.94	24.6	12.0
827	[(FC505 CMS X 562)X USSR mm T.O.]X FC712	2.94	22.9	11.9
831	[(FC505 CMS X 562)X USSR mm T.O.]X FC703/5	2.94	22.9	13.0
808	[(562 CMS X 546)X USSR mm T.O.]X FC703(4x)	2.92	24.3	12.1
834	(642027s1 CMS X 662119s1)X Rh.damp-off sel.	2.91	23.6	12.3
826	[(562 CMS X 546)X USSR mm T.O.]X FC712	2.88	22.8	12.8
849	(FC506 CMS X USSR mm T.O.)X FC703/4	2.87	22.7	12.7
811	(SP73747-01 CMS X FC708)X FC703(4x)	2.86	22.8	12.6
	HH32	3.39	25.1	13.5
	Mono Hy D2 (check)	3.32	23.4	14.2
	LSD (.05)	0.34	2.0	1.4

Performance of Experimental Hybrids Involving Rhizoctonia-Resistant Parents.--R. J. Hecker.

The best Rhizoctonia resistant hybrids from the annual general combining ability test are tested again in one or two succeeding years to establish the true worthiness of the hybrid. Table 1 lists those hybrids tested in 1982 and

ble 1. Means of experimental hybrids (susceptible CMS x Rhizoc. resistant pollinator) for disease index (inoculated field tests, Ex. 2R, 82 and 83) and yield from disease-free tests (Ex. 2, 82 and 83).

Hybrid or check	DI			Recov. suc.(T/A)			Root yield (T/A)			Sucrose (%)		
	82	83	$\bar{x}$	82	83	$\bar{x}$	82	83	$\bar{x}$	82	83	$\bar{x}$
62119s1 CMS X 562) X FC701/6	3.1	3.2	3.1	3.15	3.02	3.08	33.4	25.1	29.2	13.0	14.9	14.0
LC 129 CMS X SLC 133) X FC701/6	3.8	3.8	3.8	2.90	2.86	2.88	28.7	23.2	26.0	13.6	14.7	14.2
LC 129 CMS X French mm TO) X FC703/4	3.7	4.1	3.9	2.30	2.72	2.51	22.9	22.7	22.8	13.6	15.1	14.4
62 CMS X 546) X pooled USSR MM lines	3.6	4.0	3.8	2.53	2.51	2.52	30.8	24.9	27.8	11.9	12.9	12.4
FC504 CMS X FC502/2)X 662119s1]X USSR MM	3.0	4.2	3.6	2.21	2.13	2.17	27.9	25.6	26.8	11.6	11.5	11.6
C502/2 CMS X 662119s1)X FC702/6		4.1		2.87	2.74	2.81	23.8	21.5	22.6	12.0	15.1	13.6
C502/2 CMS X 662119s1)X FC709		3.9		2.91	2.67	2.79	25.9	21.0	23.4	11.2	15.2	13.2
C502/2 CMS X 662119s1)X FC710		3.0		2.86	2.61	2.74	23.4	20.2	21.8	12.2	15.5	13.8
C502/2 CMS X 662119s1)X FC705/1		3.0		2.79	2.59	2.69	25.5	23.0	24.2	10.9	14.4	12.6
606 CMS X FC705/1		3.5		2.88	2.58	2.73	25.0	21.5	23.2	11.5	14.5	13.0
L44 CMS X FC708)X FC705/1		2.2		2.81	2.58	2.70	23.9	22.1	23.0	11.7	14.6	13.2
L44 CMS X FC708)X FC709		2.4		2.90	2.54	2.72	24.0	21.4	22.7	12.1	14.9	13.5
LC129 CMS X USSR TO mm)X FC705/1		2.9		2.81	2.47	2.64	24.6	21.3	23.0	11.4	14.4	12.9
22112s1 CMS X 662119s1)X FC705/1		3.1		2.79	2.46	2.62	25.7	21.9	23.8	10.9	14.0	12.4
32; comm. resist. hyb.	4.1	4.0	4.0	2.28	2.92	2.60	25.5	22.5	24.0	12.5	15.5	14.0
no Hy D2; comm. hyb.	4.7	6.2	5.4	2.50	2.67	2.58	24.5	22.5	23.5	13.7	14.7	14.2
703; resistant check	2.4	2.6	2.5									
901; susceptible check	5.5	5.3	5.4									
D(.05)	1.0	1.4		0.56	0.30		2.0	1.7		0.5	0.5	

1983. The yield tests were grown disease free at the CSU Agronomy Research Center. The resistance assessments (disease index) were made in our inoculated rhizoctonia nursery.

In 1982 and 1983 only one hybrid (the same one both years) was significantly superior to the control (Mono Hy D2) for recoverable sucrose. Many of the other hybrids were higher but not significantly higher than the control. Hence, in the Ft. Collins environment, hybrids significantly better than Mono Hy D2 for sucrose production were rare. However, the rhizoctonia resistance of most of these hybrids, nearly all significantly better than Mono Hy D2, would make some of them distinctly superior in the presence of a Rhizoctonia infestation.

The two hybrids involving FC 708 in the female parent were particularly resistant with DI's of 2.2 and 2.4. FC 708 is a resistant monogerm type-O germplasm released previously. It obviously contributed additional resistance to those hybrids in which it contributed 25% of the genes present.

Under the stress of a significant amount of Rhizoctonia infection many of the hybrids in these experiments would be more productive than susceptible hybrids. However, in the absence of root rot, hybrids such as these would not be as productive as the best susceptible hybrids. It is likely that the rhizoctonia-resistant pollinators in this test would combine quite well with male steriles currently being used in commercial hybrids to produce partially resistant hybrids that would be very advantageous in fields with significant amounts of Rhizoctonia infestation. Several of the pollinators in Table 1 previously have been released to BSDF members. Any of the nonreleased pollinators could be released upon request. Breeders of BSDF member companies interested in testing any of the specific hybrids in Table 1 are welcome to our remnant seed.

Efficacy of Biocontrol Agents in Controlling Rhizoctonia Damping-off and Root Rot in Sugarbeet.--E. G. Ruppel, G. E. Harman (Cornell University), and R. J. Hecker.

A portion of our 1982 Rhizoctonia nursery, having a high soil population of Rhizoctonia solani, was used for this test. Seed of Mono Hy D2 were treated with conidia of either Gliocladium virens (G1) at 12 x 10^7 conidia/ml, Trichoderma harzianum (T95GA) at 4 x 10^7 conidia/ml, or T. koningii (T8) at 20 x 10^7 conidia/ml, with or without maneb fungicide slurry at 100 µg a.i./ml. A maneb seed treatment and a nontreated control were included in the test. All seed treatments were made in 2% Methocel A4C; 14-16 g of seed were treated with 27 ml of conidial or fungicide suspension. Excess suspension was drained off, and the seeds were air-dried.

Heavy rains and a hailstorm contributed to extremely poor stands. Thus, meaningful emergence and seedling survival data could not be obtained. However, disease index, % healthy, and % of roots in disease classes 0 through 3 data are presented in Table 1. These data are weighted averages based on the number of plants harvested from each plot.

Table 1. Effect of three biocontrol agents with and without maneb as seed treatments for the control of rhizoctonia root rot.

Seed treatment	Disease index	% healthy	% in disease classes 0-3
Gliocladium virens	3.4	29.4	59.4
G. virens + maneb	4.2	22.8	42.0
Trichoderma harzianum	4.2	17.3	43.8
T. harzianum + maneb	4.3	12.4	34.5
T. koningii	4.5	0.5	35.3
T. koningii + maneb	3.9	11.2	48.7
Maneb	4.1	10.9	43.7
Nontreated control	4.2	15.1	33.6

There were no significant differences among treatments for any statistical parameter. All biocontrol agents and maneb failed to significantly reduce the intensity of root rot as compared with the nontreated control.

Population Densities of Rhizoctonia in Soil Following Growth of Rhizoctonia-Resistant and Susceptible Sugarbeets.--E. G. Ruppel and R. J. Hecker.

(This research was partially supported by a grant from the Grower-Great Western Joint Research Committee, Inc.)

Sugarbeet cultivars FC 707 (highly resistant), FC 703 (resistant), HH 32 (intermediately resistant), and Mono-Hy D2 and D7 (both susceptible were grown in the greenhouse in autoclaved (A) and nonautoclaved (NA) soil (three plants per 10-cm-diameter pot; five replications). The A soil was amended with Rhizoctonia solani (R-9) inoculum to a concentration of 0.05 propagules per g soil; NA soil was diluted with sterilized soil to yield a final concentration of 0.05 propagules per g of indigenous Rhizoctonia. This soil had been collected from our Rhizoctonia breeding nursery and contained a high population density of AG-2 Rhizoctonia. After 60 days of growth, the cultivars were harvested and the final population density of Rhizoctonia was determined for each pot via a selective medium. Additionally, population densities of potential biocontrol agents Trichoderma and Pseudomonas were assayed at the beginning and end of the experiment. Bioassays of pathogenic Rhizoctonia were conducted at the beginning and end of the experiment, and damping-off data were collected.

Less initial damping-off of the cultivars occurred in A than in NA soil; however, Rhizoctonia population densities after 60 days growth of the cultivars increased 50- to 70-fold in the former as compared with only 30- to 62-fold in the latter soil (Table 1). In the NA soil, known resistance of the cultivars

Table 1. Effect of growing Rhizoctonia-resistant and susceptible sugarbeet for 60 days on the population density of Rhizoctonia, and subsequent damping-off of a susceptible sugarbeet planted in the same soils (means of two trials, five replicates per trial)

Soil	Cultivar	% Initial damping-off[1]	Final Rhizoctonia propagules/g soil	% Mono-Hy D2 damping-off
Non-autoclaved	FC 707	53.2	3.4	72
	FC 703	46.9	3.6	87
	HH 32	40.4	3.5	85
	Mono-Hy D2	4.4	2.5	87
	Mono-Hy D7	0	2.8	81
Autoclaved	FC 707	92.1	1.5	77
	FC 703	84.5	1.8	48
	HH 32	96.5	3.1	58
	Mono-Hy D2	88.9	2.5	76
	Mono-Hy D7	97.4	1.9	86

[1]Data are expressed as percent of control survival in autoclaved soil without Rhizoctonia.

was directly correlated to the amount of initial damping-off; i.e. the higher the resistance the greater the amount of damping-off. This conceivably was due to pathogens other than Rhizoctonia (e.g. Pythium) which probably were present in the natural field soil. Damping-off in the A soil (with added Rhizoctonia) was unexpectedly high for the low initial population of Rhizoctonia, but

differences among cultivars were not significant. The increased virulence of Rhizoctonia in this soil possibly was due to the lack of competition and/or antagonism from other organisms killed by autoclaving.

Damping-off of Mono-Hy D2 replanted after harvest of the test cultivars was not significantly different among the NA cultivar soils; however, there was a trend toward less damping-off in A soils in which resistant cultivars had been grown compared with soils that had supported growth of susceptible cultivars. This effect was quite variable, however, and additional study is warranted. Across all cultivar soils, more damping-off of Mono-Hy D2 occurred in NA soil (82.4%) than in A soil (69%), which apparently is associated with the higher population density of Rhizoctonia in the former as compared with the latter soil (mean of 3.2 vs. 2.2 propagules/g, respectively).

Initially, population densities of potential biocontrol agents of Trichoderma and fluorescent pseudomonads were 13,200 and 7,600 propagules/g soil, respectively. By harvest of the cultivars, Trichoderma populations in the NA cultivar soils had decreased from 91 to 99%, with no apparent cultivar effect; Pseudomonas populations, however, had increased from 79- to 108-fold, with a trend toward an inverse relationship between cultivar resistance and propagule density (Table 2). That is, the higher the resistance level the lower the

Table 2. Effect of growing Rhizoctonia-resistant and susceptible sugarbeet cultivars for 60 days on the soil population densities of Trichoderma and Pseudomonas in the presence of Rhizoctonia; means of two trials, five replicates per trial

Initial soil	Cultivar grown	Final propagules/g soil	
		Trichoderma	Pseudomonas ($X10^4$)
Non-autoclaved	FC 707	380	70
	FC 703	1,190	76
	HH 32	110	83
	Mono-Hy D2	180	86
	Mono-Hy D7	460	63
Autoclaved	FC 707	6,570	34
	FC 703	2,380	36
	HH 32	1,230	63
	Mono-Hy D2	410	65
	Mono-Hy D7	170	35

density of Pseudomonas.

In the A cultivar soils, Trichoderma levels decreased from 50 to 99%. In this case, however, the decreases were directly associated with the known resistance levels of the cultivars, i.e. the smallest decrease (50%) occurred in soil in which the most resistant FC 707 was grown, whereas the greatest decrease was found in soil used to grow susceptible Mono-Hy D7. Increases in Pseudomonas populations (from 43- to 81-fold), again were inversely related to cultivar resistance level; except for Mono-Hy D7, the higher the resistance level the lower the Pseudomonas density.

The significance of the apparent cultivar effect on soil populations of Trichoderma and Pseudomonas in A soil, and with Pseudomonas in NA soil is not easily explained. The higher levels of known Rhizoctonia antagonist Trichoderma in the A soil probably contributed to the lower increases in the pathogen density in such soil as compared with NA soil. But the suppression of the pathogen was not sufficient to significantly control subsequent damping-off of Mono-Hy D2, and there was no apparent relationship in the level of Rhizoctonia and the amount of damping-off in the A soil. The large increases in Pseudomonas densities might be expected in soils containing rotting organic matter such as damped-off beets. However, additional studies are needed to explain the apparent cultivar effect that we observed.

CERCOSPORA/CURLY TOP RESISTANCE BREEDING AND RELATED RESEARCH (BSDF PROJECT 25)

1983 Cercospora Field Research--G. A. Smith and E. G. Ruppel

The 1983 cercospora field research supported by BSDF project 25 was conducted for the second year on property owned by Colorado State University, and located just west of the CSU veterinary research and teaching center. The leaf spot nursery was planted April 28. A freeze occurred on May 11 (temperature 25° F) which killed many seedlings, especially on the west half of the field. Fortunately, the majority of company-submitted lines and the breeding nursery were located to the east and suffered little damage. The cercospora nursery was inoculated on July 14 and July 21. Conditions for development of leaf spot this year were good, and the epiphytotic peaked about August 22. Leaf spot evaluations were made August 22 and 29.

Leaf Spot Evaluations of Sugarbeet Lines Submitted by BSDF-Member Companies.--E. G. Ruppel and G. A. Smith

Separate randomized complete block designs with two replications were used to evaluate a total of 211 breeding lines submitted by American Crystal, Betaseed, Bush Johnson, Great Western, Hilleshog, Holly, and Mennesson companies for resistance to Cercospora beticola. Internal checks included a highly susceptible synthetic, and leaf spot resistant FC(504 x 502/2) x SP6322-0. Two-row plots were 4 m long with 56 cm between rows. The mean rating on August 22 of the susceptible check across all company tests was 6.9, whereas the resistant check was 4.8. Company lines ranged from 3.8 to 7.8 on this date. Results of the individual tests were tabulated, statistically analyzed, and sent to each respective contributor.

Breeding for Resistance to Cercospora and Curly Top Virus 1983.--G. A. Smith and E. G. Ruppel

The leafspot epidemic in our 1983 nursery was moderate to severe. Some reductions in stand followed the May 11 freeze, but stands were very adequate for critical evaluation of the breeding lines. The leaf spot resistant check in the breeding nursery averaged 3.7, and the susceptible check 5.8. The curly top epidemic at Logan was moderate. U.S. 41 averaged 3.5, and susceptible U.S. 33 averaged 5.8. Only selected entries from the Ft. Collins breeding program are tested for curly top reaction at Logan.

The results from our breeding program nursery tests for 1983 are presented in Table 1. Forty-seven of the 150 entries evaluated for leaf spot resistance equaled or exceeded the resistance of the long term check (entries 1449 and 1450). FC 606 and FC 607 (entries 1415-1418) were advanced to the C_4 generation for further seed increase. These entries will be released in the near future. As can be seen in Table 1, the diploid and tetraploid versions of these lines exhibit about the same resistance to Cercospora. The tetraploid versions may provide a dosage effect when used in synthesizing triploids. Two more diploid monogerm lines with high Cercospora resistance are being increased for future release.

Table 1. Mean leaf spot and curly top ratings of some breeding lines and other entries at Ft. Collins, CO, and Logan, UT, 1983.

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1301	821036 H02	(662119s1 CMS X 562) X FC607 T.O.	3.5	3.5
1302	821036 H03	502/3 CMS X FC607 T.O.	3.5	4.5
1303	821036 H04	1861 CMS X FC607 T.O.	3.3	3.5
1304	821036 H05	721055 CMS good C.A. for CTR X FC607 T.O.	3.8	4.5
1305	821036 H07	FC504 CMS X FC607 T.O.	3.8	4.5
1306	821036 H08	662119s1 CMS X FC607 T.O.	3.3	2.5
1307	821039 H02	(622112s1 CMS X 662119s1 T.O.) X FC606 T.O.	5.0	1.5
1308	821039 H03	(FC605 CMS X FC502/3 T.O.) X FC606 T.O.	4.3	2.0
1309	821039 H05	(FC504 CMS X FC502/2) X FC606 T.O.	4.0	4.0
1310	821039 H06	FC506 CMS X FC606 T.O.	3.3	3.0
1311	821039 H07	721055 CMS good C.A. for CTR X FC606 T.O.	3.8	2.0
1312	821041 H02	FC605 CMS X FC502/3 T.O.	2.5	
1313	821041 H03	(622112s1 CMS X 662119s1 T.O.) X FC502/3 T.O.	4.8	
1314	821041 H01	FC502/3 CMS X FC502/3 T.O.	4.3	
1315	821041 H05	1861 CMS X FC502/3 T.O.	4.8	
1316	821041 H06	FC506 CMS X FC502/3 T.O.	3.8	
1317	821045 H02	(FC605 CMS X FC502/3 T.O.) X 721055 T.O.	3.0	4.0
1318	821045 H03	FC607 CMS X 721055 T.O.	4.8	4.0
1319	821045 H04	FC506 CMS X 721055 T.O.	4.5	4.5
1320	821050 H02	(622112s1 CMS X 662119s1 T.O.) X SP6322-0 MM	3.5	
1321	821050 H03	(662119s1 CMS X 562) X SP6322-0 MM	4.5	
1322	821050 H04	(FC605 CMS X FC502/3 T.O.) X SP6322-0 MM	4.5	
1323	821050 H05	FC607 CMS X SP6322-0 MM	4.0	
1324	821050 H06	721055 CMS good C.A. for CTR X SP6322-0 MM	3.0	
1325	821050 H07	FC504 CMS X SP6322-0 MM	3.8	
1326	821050 H08	662119s1 CMS X SP6322-0 MM	3.8	
1327	821054 H2	(662119s1 CMS X 562) X Spanish LS "Tolerant" line 4x	4.0	
1328	821054 H3	721055 CMS good C.A. for CTR X Spanish LS "Tolerant" line 4x	3.0	
1329	821054 H4	662119s1 CMS X Spanish LS "Tolerant" line 4x	3.0	
1330	821055 H2	(662119s1 CMS X 562) X Spanish LS "Tolerant" line 4x	4.0	
1331	821055 H3	721055 CMS good C.A. for CTR X Spanish LS "Tolerant" line 4x	5.3	
1332	821055 H4	662119s1 CMS X Spanish LS "Tolerant" line 4x	4.3	
1333	821056 H3	FC504 CMS X Spanish LS "Tolerant" line 4x	2.0	
1334	821056 H4	662119s1 CMS X Spanish LS "Tolerant" line 4x	5.3	
1335	821057 H2	(662119s1 CMS X 562) X Spanish LS "Tolerant" line 4x	5.8	
1336	821057 H3	FC504 CMS X Spanish LS "Tolerant" line 4x	2.8	
1337	821057 H4	662119s1 CMS X Spanish LS "Tolerant" line 4x	4.3	
1338	821058 H2	(662119s1 CMS 562)X Spanish LS "Tolerant" line 4x	4.8	
1339	821058 H3	662119s1 CMS X Spanish LS "Tolerant" line 4x	2.3	
1340	821059 H2	(FC504 CMS X FC502/2) X Aula Dei 645 (4x) LSR	3.0	
1341	821059 H3	662119s1 CMS X Aula Dei 645(4x) LSR	3.8	
1342	821060 H2	(622112s1 CMS X 662119s1 T.O.) X HSI 301,4x, MM,rr,R	4.3	6.5

Table 1. Mean leaf spot and curly top ratings . . . continued

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1343	821060 H3	(662119s1 CMS X 562) X HSI 301,4x,MM,rr,R	4.3	6.5
1344	821060 H4	(FC504 CMS X FC502/2) X HSI 301,4x,MM,rr,R	4.0	7.0
1345	821060 H5	1861 CMS X HSI 301,4x,MM,rr,R	4.3	
1346	821061 H2	FC605 CMS X HSI 501,4x,MM	5.3	6.0
1347	821061 H3	(622112s1 CMS X 662119s1 T.O.) X HSI 501,4x,MM	4.3	5.5
1348	821061 H4	(662119s1 CMS X 562) X HSI 501,4x,MM	5.5	6.5
1349	821061 H5	(FC504 CMS X FC502/2) X HSI 501,4x,MM	5.0	6.5
1350	821061 H7	662119s1 CMS X HSI 501,4x,MM	5.5	6.0
1351	821062 H2	FC605 CMS X HSI 101,4x,MM	4.5	5.5
1352	821062 H3	(622112s1 CMS X 662119s1 T.O.) X HSI 101,4x,MM	5.8	5.0
1353	821062 H4	(662119s1 CMS X 562) X HSI 101,4x,MM	5.5	5.0
1354	821062 H5	(FC504 CMS X FC502/2) X HSI, 101,4x,MM	5.3	6.5
1355	821062 H7	662119s1, CMS X HSI 101,4x,MM	4.5	5.0
1356	811001 HO6	(FC605 CMS X FC502/3T.O.)X FC708 T.O.	4.0	
1357	811001 HO7	FC605 CMS X FC708 T.O.	5.5	
1358	811001 HO8	(652016s1 CMS X FC605) X FC708 T.O.	3.8	
1359	811002 HO5	652016s1 CMS X FC708 T.O.	3.8	
1360	811003 HO2	662119s1 CMS X FC607 T.O.	3.3	3.5
1361	811004 HO2	FC607 CMS X SP 74564-0 T.O.,mm	4.5	
1362	811004 HO3	FC506 CMS X SP 74564-0 T.O.,mm	4.3	
1363	811004 HO4	FC606 CMS X SP 74564-0 T.O.,mm	3.5	
1364	811006 HO2	FC607 CMS X FC608 T.O.	3.5	3.5
1365	811006 HO3	FC506 CMS X FC608 T.O.	3.5	
1366	811008 H2	FC607 CMS X SP 6322-0, MM	4.0	
1367	811008 H3	FC606 CMS X SP 6322-0, MM	4.5	
1368	811008 H4	662119s1 CMS X SP 6322-0, MM	3.8	
1369	811008 H5	FC608 CMS X SP 6322-0, MM	3.8	
1370	811008 H6	FC(504CMS X 502/2 T.O.)X SP 6322-0,MM	4.3	
1371	811008 H7	(662119s1 CMS X FC605)X SP 6322-0,MM	3.3	
1372	811008 H8	(FC603 CMS X FC605)X SP 6322-0,MM	4.8	
1373	811008 H9	(1861 CMS X FC605)X SP 6322-0,MM	3.8	
1374	811008 H10	(642027s1 CMS X 662119s1 T.O.) X FC605 T.O. X SP 6322-0, MM	5.0	
1375	811008 H11	(632028s1 CMS X FC605 T.O.) X SP 6322-0, MM	4.3	
1376	811009 H3	(652016s1 CMS X 662119s1 T.O.) X FC604 T.O. X SP 6322-0,MM	4.0	
1377	811009 H4	(FC605CMS X FC502/3 T.O.)X SP6322-0,MM	3.8	
1378	811009 H5	(FC605CMS X 761036HO mm)X SP6322-0,MM	4.3	
1379	811009 H6	(652016s1 CMS X 662119s1 T.O.) X SP6322-0 MM	3.8	
1380	811009 H7	(662112s1 CMS X 662119s1 T.O.) X SP6322-0 MM	5.3	
1381	811009 H8	(1861 CMS X FC606 T.O.) X SP6322-0 MM	5.0	
1382	811010 H2	FC607 CMS X 761016 H MM non-T.O.	3.5	
1383	811010 H3	FC606 CMS X 761016 H MM non-T.O.	4.5	
1384	811010 H4	FC608 CMS X 761016 H MM non-T.O.	4.3	
1385	761036 HO	Selected from 662110s1 T.O.	4.3	
1386	811011 HO2	FC506 CMS X 761036 HO mm,662110s1 T.O.	2.8	
1387	811011 HO3	662119s1 CMS X 761036 HO mm,662110s1 T.O.	4.5	2.0

Table 1. Mean leaf spot and curly top ratings . . . continued

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1388	811011 H04	(662119s1 CMS X FC605 T.O.) X 761036 HO mm, 662110s1, T.O.	3.3	1.5
1389	811011 H05	(FC603 CMS X FC605 T.O.) X 761036 HO mm, 662110s1 T.O.	3.8	
1390	811011 H06	(1861 CMS X FC605 T.O.) X 761036 HO mm, 662110s1 T.O.	4.0	
1391	811011 H07	(632028s1 CMS X FC605 T.O.) X 761036 HO mm, 662110s1 T.O.	4.0	2.0
1392	811011 H09	FC605 CMS X 761036 HO mm, 662110s1 T.O.	4.0	
1393	811012 H02	(652016s1 CMS X FC605) X 761036 HO mm, 662110s1 T.O.	3.5	
1394	811012 H03	FC(605 CMS X 502/2 T.O.) X 761036 HO mm,662110s1 T.O.	2.0	
1395	811012 H04	(652016s1 CMS X 662119s1 T.O.) X 761036 HO mm, 662110s1 T.O.	4.5	
1396	811012 H05	(622112s1 CMS X 662119s1 T.O.) X 761036 HO mm, 662110s1 T.O.	5.0	1.0
1397	811012 H07	FC502/3 CMS X 761036 HO mm, 662110s1 T.O.	3.8	
1398	811012 H08	(1861 CMS X FC606 T.O.) X 761036 HO mm, 662110s1 T.O.	3.0	
1399	811015 H02	662119s1 CMS X FC605 T.O.	3.0	3.0
1400	811015 H03	(622112s1 CMS X 662119s1 T.O.) X FC605 T.O.	2.8	2.0
1401	811025 H2	FC606 CMS X Spanish LS "Tolerant" line 4x,740002	4.0	
1402	811025 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4x,740002	4.0	
1403	811026 H2	FC606 CMS X Spanish LS "Tolerant" line 4x 740008	4.3	
1404	811026 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4x 740008	4.3	
1405	811027 H2	FC606 CMS X Spanish LS "Tolerant" line 4x,740010	3.3	
1406	811027 H3	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line,4x,740010	3.5	
1407	811028 H2	FC606 CMS X Spanish LS "Tolerant" line 4x, 740004	4.8	
1408	811028 H3	(632028s1 CMS X FC605 T.O.) X Spanish LS "Tolerant" line 4x, 740004	4.0	
1409	811028 H4	(FC605 CMS X 1861 T.O.) X Spanish LS "Tolerant" line 4x, 740004	3.3	
1410	811029 H2	(632028s1 CMS X FC605 T.O.) X Spanish LSR,645,4x,740480	4.5	
1411	811029 H3	(FC605 CMS X 1861 T.O.) Spanish LSR,645,4x,740480	3.0	
1412	811031 H	Aula Dei 645(4x) LSR	3.8	
1413	811031 H2	FC606 CMS X Aula Dei 645 (4x) LSR	4.5	
1414	811031 H3	(632028s1 CMS X FC605 T.O.) X Aula Dei 645 (4x) LSR	4.0	
1415	821034 H0	FC606 T.O. 4x	4.0	
1416	821034 H01	FC606 CMS 4x	2.8	

Table 1. Mean leaf spot and curly top ratings . . . continued

Entry no.	Seed no.	Description	Leaf spot[1]	Curly top[1]
1417	821097 H0	FC607 T.O. 4x	3.5	
1418	821097 H01	FC607 CMS 4x	2.3	
1419	811019 H0	FC607 T.O. Reselected	4.5	
1420	811019 H01	FC607 CMS Reselected	4.0	
1421	811020 H0	FC606 T.O. Reselected	4.5	
1422	811020 H01	FC606 CMS Reselected	4.0	
1423	801123 H0	FC607 T.O. Reselected	3.5	
1424	A78-44	FC606 T.O. (official release)	3.8	
1425	A78-45	FC606 CMS (official release)	3.3	
1426	A79-67	FC607 T.O. (official release)	3.8	
1427	A79-68	FC607 CMS (official release)	3.0	
1428	A81-62	Mono Hy E4	3.3	
1429	801095 H04	FC(504 CMS X 502/2) X FC606 T.O.	4.3	
1430	801096 H02	FC608 CMS X 761036 H0 from 662110s1	4.0	
1431	801096 H06	(642027s1 CMS X 662119s1 T.O.) X 761036 H0,mm from 662110s1 LSR-CTR	3.3	
1432	801096 H08	FC506 CMS X 761036 H0 mm from 662110s1 LSR-CTR	2.5	
1433	791013 H03	FC502/3 CMS X FC605 T.O. mm	3.5	
1434	791013 H04	662119s1 CMS X FC605 T.O. mm	3.3	2.5
1435	791013 H05	FC603 CMS X FC605 T.O. mm	4.0	3.5
1436	791013 H06	642027s1 CMS X FC605 T.O. mm	3.5	
1437	791013 H08	(642027s1 CMS X 662119s1 T.O.) X FC605 T.O.	4.3	
1438	791013 H09	632028s1 CMS X FC605 T.O. mm	4.3	
1439	791015 H02	FC605 CMS X FC502/2 T.O.	3.5	
1440	791015 H04	(652016s1 CMS X FC605) X FC502/2 T.O.	3.8	
1441	791016 H03	FC606 CMS X FC502/3 T.O.	3.8	
1442	791019 H04	FC502/2 CMS X 661153 H0; 642027s1=FC603 T.O.	3.5	
1443	791019 H05	FC606 CMS X 661153 H0; 642027s1=FC603 T.O.	4.3	2.5
1444	791019 H06	(652016s1 CMS X FC605) X 661153 H0; 642027s1=FC603 T.O.	3.0	
1445	791024 H02	FC502/2 CMS X 622027s1, 642010s1 T.O.	2.5	
1446	791056 H9	FC607 CMS X Syn. of G.H. rh. sel from FC703	4.3	
1447	771077	US 201 LSR,MM	4.5	
1448	751102 H05	FC506 CMS X FC605 T.O.	3.0	
1449	761042 H2	LSR check, FC(504 X 502/2) X SP6322-0	3.5	
1450	821051 H2	LSR check, FC(504 X 502/2) X SP6322-0	4.0	
1451	A63-5	ILSR check, SP5822-0	4.3	
1452	771056 H	LSS check, Synthetic check	5.8	
	US41	CTR check		3.5
	US33	CTS check		5.8
	LSD .05		1.69	

[1]Leaf spot and curly top ratings based on 0-10 scale with 0 = no symptoms and 10 = dead for curly top or complete defoliation for leaf spot.

Effect of Light on Sporulation, and Predisposition to Germination and Germ-Tube Growth of Cercospora beticola conidia in vitro.--E. G. Ruppel.

Mycelial suspensions of 7-day-old cultures of Cercospora beticola isolates C-1 (Colorado) and F-573 (Germany) were used to uniformly seed petri dishes of sugarbeet leaf-extract agar. A third of the culture plates were covered with aluminum foil, and gas-exchange slits were made between the lid and base of each dish. All dishes were placed in a lighted incubator at 15C. After 3 days, another third of the dishes were covered with aluminum foil and returned to the incubator. After 6 days of total incubation, conidia were harvested from all cultures. Their concentration from each suspension was determined with the aid of a hemacytometer. Subsequent percent germination was determined after 24 hr in sterile distilled water, and the longest germ-tube of 20 conidia per treatment per isolate was measured with an ocular micrometer. A randomized block design was used with six replicates in each of two trials. Results are presented in Table 1 as the means of two trials.

Table 1. Effect of light on sporulation, and conidial germination and germ-tube growth of Cercospora beticola in vitro; means of two trials, six replicates per trial.

Isolate	Cultural treatment[1]	Sporulation (conidia/ml x 10^4)	Germination[2] (%)	Germ-tube length[2] (μm)
C-1	L	94.2	99.2	275.2
	D	10.9	99.1	241.0
	L/D	57.0	99.4	241.3
F573	L	197.3	97.5	233.5
	D	123.3	92.8	281.0
	L/D	136.3	94.6	226.5

[1]L = 6 days continuous light; D = 6 days continuous dark; L/D = 3 days light followed by 3 days dark.

[2]Germination in sterile distilled water; data collected 24 hr after harvest.

Light treatment, as reported in the literature, significantly affected sporulation of Cercospora beticola in vitro. Most conidia of both isolates were produced under continuous light, followed by half

light and half dark treatment. In continuous darkness, 88 and 38% fewer conidia were produced by isolated C-1 and F573, respectively, as compared with the continuous light regime. Isolate F573, our most virulent isolate, was the most prolific spore producer in all treatments.

None of the light regimes had a significant effect on subsequent germination or germ-tube growth of the conidia.

SUGARBEET QUALITY IMPROVEMENT RESEARCH
(BSDF Project 53)

This project will terminate at the end of this BSDF fiscal year. Some of the data analyses and reporting of the final phases of research in this project will not be completed until after the project has ended. The termination of this project is also in keeping with redirections within the Agricultural Research Service. This does not mean that beet quality is any less important to beet processors and growers. However, the basic knowledge and technology to produce high quality beets is now well developed, having been done through this and other BSDF projects, industry research, grower sponsored research, as well as USDA and state experiment station research. Knowledge transfer and technology adoption are now in process, albeit slow. High quality beets only come from the growers. With available information and technology, they should be able to produce high quality beets, provided economic incentive and available technical information are adequate.

Our research on quality (BSDF Project 53) at Ft. Collins has contributed significantly to establishing the importance of genetic control of quality relative to cultural practices, especially fertilization. From our research we know that genetic improvements in quality can be made, but the overpowering and dominant influence is nitrogen fertility and management. We also know that high quality and high sucrose production are simultaneously attainable, genetically. Hence, quality improvement can be achieved by cooperation of growers and variety developers if powered by a common or shared economic incentive.

Effect of Selection for Low and High Amino Nitrogen on Yield, Sucrose, and Combining Ability--R. J. Hecker and S. S. Martin.

Our 1983 field test of populations resulting from six cycles of selection for low and high amino N in beets is the final phase of this study. In this final phase we compared at two N fertility levels sucrose production and quality of the low and high amino N populations. Additionally, we compared the combining ability of these populations relative to their parental source. The objectives of this study are three-fold: (1) to discover new information about the genetic control of amino N levels in beets at harvest; (2) to assess the effectiveness of rigid selection for low amino N content; and (3) to measure the effect of any amino N change on the general combining ability of the resultant

selected populations.

The analyses of the data from this final experiment are not completed. The final results of the study will be reported later. Early indications are that amino N content was significantly changed by the six cycles of selection (both low and high amino N selections), and that the low selection had increased sucrose but slightly depressed root yield relative to the high amino N selection. Low amino N germplasms of potential commercial usefulness will be released to BSDF members.

Post-storage Selection for Quality Improvement--R. J. Hecker, S. S. Martin and G. A. Smith.

We have completed three cycles of full mass selection (selection of both female and male phenotypes) to test the hypothesis that post-storage beet quality can be genetically improved by making post-storage phenotypic selections. The second year of field testing of resultant selected populations for production performance per se and for combining ability was done in 1983. Samples were analysed at harvest (Oct. 83), and 100 days post-storage. However, the data is not yet completely analysed. Meanwhile, the data from the first year of field testing is shown in Table 1. The parallel selection programs, selection at optimum and high nitrogen fertilization, resulted in improved purity, purity components, and sucrose, reduced root yield, and unchanged recoverable sucrose. Hence, improvements were achieved in purity and sucrose, but were countered by reduced root yield so that recoverable sucrose was unaffected. General combining ability, as measured by hybridization of the selected lines to a common set of five male sterile testers, was not significantly different between the two selected lines, or between the selected lines and their source (SP6322-0). These were all analyses made at harvest. Post-harvest analyses for purity, sucrose, and purity components were made in Feb. 84 and final results of this study will be reported later. Any potentially useful germplasms will be released to BSDF members.

Table 1. Means of three cycles of mass selection for post-storage quality, and combining-ability-test means (Ex. 7, 82).

Description	Purity	Amino N	Na	K	Sucrose	Recov. suc.	Root wt.
	(%)	(--mg/100 g suc--)			(%)	(T/A)	(T/A)
Source; SP6322-0	79.7	.431	2.76	2.28	9.0	1.01	19.8
1st cy sel at opt. N	81.4	.384	2.46	1.94	9.7	1.02	17.2
2d cy sel at opt. N	82.2	.339	2.32	1.66	10.0	0.93	14.9
3d cy sel at opt. N	83.3	.301	2.07	1.54	10.5	0.99	14.7
1st cy sel at high N	80.1	.435	2.80	2.08	9.0	0.84	16.6
2d cy sel at high N	82.2	.338	2.42	1.53	9.8	0.85	14.2
3d cy sel at high N	83.0	.316	2.22	1.42	10.2	0.82	12.8
CMS's X SP6322-0	82.7	.341	2.20	1.75	10.1	1.14	20.4
CMS's X 3d cy sel opt. N	83.3	.314	2.05	1.63	10.5	1.22	20.3
CMS's X 3d cy sel high N	83.8	.330	2.16	1.68	10.2	1.16	20.2
LSD(.05)	1.3	.048	0.35	0.17	0.6	0.15	1.8

RAPID SELECTION AND REGENERATION OF ELITE SUGARBEET GENOTYPES

(BSDF Project 75)

G. A. SMITH

Much effort has gone into working out the many procedural "bugs" that will occur in a project like this. Whereas some problems have not been solved, some major accomplishments have been made. First, the ability to consistently and rapidly root most genotypes in vitro allows rapid multiplication and establishment of clonal lines in Beta vulgaris, which is a valuable breeding tool for preservation of elite or desirable genotypes. Second, we have been able to develop most of the procedures necessary for the isolation (selection) of elite genotypes. Since the basic procedure has been worked out and carried through many times, it is possible to observe the process and make refinements if necessary. This basic procedure lends itself to many situations, and can be applied to numerous problems. It is now possible to incorporate new objectives as they are encountered (such as fungal toxin selection, and pollen screening). The techniques represent flexible and valuable tools that are nearly ready for use by the plant breeder. These methods can fit into most plant breeding programs, and complement and strengthen the conventional approaches.

Problem Areas and Progress

In addition to our in vitro selection and propagation of ethofumesate-tolerant genotypes, we have also investigated three new areas of research.

First, we have attempted to use many of the techniques developed in screening for herbicide tolerance to select genotypes that respond to certain plant growth regulators. Once such genotypes are identified, a population can be "custom" built that will respond to application of the growth regulator. Second, we have begun to use typical callus culture techniques to isolate herbicide-tolerant mutants. Third, we are looking into the possibility of screening for traits, such as herbicide tolerance, at the gametophytic level (i.e. pollen screening) to complement the screening done at the sporophytic level.

To date, we have made over 30 selections in vitro that seemed to show tolerance to ethofumesate (Nortron). These selections were challenged on media containing four to six times the recommended field rate. Whereas most of these selections are still in the multiplication phase, seed from a few lines has been harvested. Most of this seed has been evaluated in the greenhouse. So far, the results are mixed. Initially, the screened material performed 20% better than the unscreened material at high concentrations of ethofumesate. Subsequent testing, however, failed to produce the same results. Recently, a refinement in the technique has been made that promises to greatly increase the accuracy of selection. This new technique results in uniform exposure to the chemical agent in the media. Initial results indicate that much higher concentrations of challenging chemicals are needed to isolate truly tolerant types. This technique should make progress more rapid by increasing the accuracy of the selection process.

We have been able to initiate callus from a limited number of lines, but have not had enough time to induce regeneration. Plans are to isolate callus on lower concentration BA media and then transfer the callus to regeneration media containing higher concentrations of BA plus ethofumesate. If regeneration is noted on these selective media, recovered ramets may be tolerant to the herbicide.

The basic assumption behind pollen screening is that many of the genes operative during the sporophyte stage also will be operative during the gametophytic stage. Thus, if a herbicide or toxin is toxic to the whole plant (the sporophyte), then it may be recognized in the gametophyte (pollen) as well. The toxicity at the gametophytic stage will be manifested in the inhibition of pollen tube germination and elongation. Pollen from a tolerant line will exhibit more vigorous tube formation under selective conditions. So far, two clonal lines have been tested in this manner. One line exhibited a 31% decrease in pollen germination at 10 ppm ethofumesate, whereas the other line showed no inhibition at the same rate. Further work attempting to correlate the response of pollen in vitro to the response of the same genotype in vivo is needed before this method can be used.

FEASIBILITY OF PREDICTING HYBRID VIGOR FROM GAMETOPHYTE-SPOROPHYTE COMPLEMENTATION
(BSDF Project 76)

R. J. Hecker

The objective of this project is to test greenhouse and laboratory methods of predicting hybrid vigor for root yield in beets. Such methods would be useful as an early screening for potentially good hybrids to reduce the number of experimental hybrids that normally would have to be synthesized and field tested. To be useful, such techniques should have prediction accuracies of over 50%, but preferably of 95%. The hypothesis being tested in experiments of this project is that the degree of genetic complementation expressed as hybrid vigor can be detected and measured by the complementation that occurs between the pollen tube (male gametophyte) and the stylar tissue (female sporophyte) in which the tube is growing. Hence, that female and male combination with the greater expression of hybrid vigor should have the most rapid growth of the male pollen tube in the female style, and pollen from that male should effect fertilization most frequently when in competition with some less complementary pollen.

During the first 9 months of work on this project, I have identified several half-sib pairs of hybrids where the CMS X pollinator A had good hybrid vigor for root yield, but the same CMS X pollinator B had poor hybrid vigor. Breeders of several BSDF member companies have been most cooperative by supplying similar high- and low-yield half-sib pairs of hybrids. Sixteen such pairs were planted in a field experiment to confirm the relative high- and low-yield of each hybrid pair. The 16 CMS parents are in various stages of being pollinated with an equal pollen mix from pollinator A (green hypocotyl) and pollinator B (pink hypocotyl) that had produced a specific high- and low-yield hybrid pair. The frequency of successful fertilization by pollinators A & B in each of the 16 cases will be related to the root yields of the half-sib hybrids in the field.

At this time, the yield tests in the field have been completed but the data have not been analysed. Controlled hybridizations in the greenhouse have been made, and resultant seed are being harvested. Seed productions have been good, up to 2000 seed per CMS plant. Two to six controlled pollinations with the mixed pollen have been made on each CMS plant. The lack of a rapid accurate pollen viability test has necessitated the use of an equal mix of pollen from male A & B. If the viability of the two pollen sources were different, the frequency of fertilization could be a confounded effect of pollen viability and gametophyte-sporophyte complementation. Thus, we are trying to develop a rapid accurate pollen vital-staining technique. Analyses of field data and greenhouse hybridizations will be completed and reported subsequently. If this technique is successful, it would provide a relatively low cost, large scale screening in the greenhouse of potential hybrids before moving into expensive hybridizations and field testing.

CLARIFICATION OF SUGARBEET EXTRACTS

(BSDF Project 81)

Sugarbeet Extract Clarification.--S. S. Martin

A review of literature on the sources and nature of colored impurities and on potential color-producing reactions in sugarbeet extracts was reported earlier (Sugarbeet Research Report, 1981). The clarification of sugarbeet extracts for polarimetric sucrose determination requires two actions: (1) the prevention of formation of colored compounds, particularly the products of polyphenoloxidase action, or the removal of such compounds once formed; and (2) the removal of macroscopic and colloidal debris. The first can be accomplished by a variety of means, and the second is in simplest form a filtration process, avoiding centrifugation or more complicated laboratory techniques not readily used on numerous samples or in automated procedures.

In preliminary laboratory tests with frozen sugarbeet brei, representatives of several classes of possible clarificants were tested for their decolorizing potential. Antioxidants, polyphenol adsorbents, copper chelators and other polyphenol oxidase inhibitors, and strongly basic anion exchange resins were tested singly and in selected combinations. Among the materials tested were dithiothreitol, polyvinylpyrrolidone, borate (pH 9.0), sodium diethyl-dithiocarbamate, 8-hydroxyquinoline, various sulfhydryl reagents, peroxide, sodium metabisulfite, activated magnesium silicate, and several basic Amberlite ion exchange resins. Most reagents theoretically capable of inhibiting or inactivating polyphenol oxidase had at least some decolorizing effect, although the solution often was turbid (after Whatman No. 1 filtration). Polyvinylpolypyrrolidone, which often is used to remove phenolic compounds that hydrogen-bond to proteins, does not bind tyrosine effectively (Loomis, 1969), and thus could be expected to be relatively ineffective with the major substrate for sugarbeet polyphenol oxidase; tests with a range of concentrations confirmed these expectations. The best results were obtained with sulfhydryl reagents such as mercaptoethanol and mercaptoacetic acid, which Gross and Coombs (1976) previously had shown were the most effective inhibitors of sugarbeet polyphenol oxidase. These compounds decolorized even heavily pre-oxidized brei samples. It thus appeared that prevention of early activity of polyphenol oxidase was more desirable and effective than removal of polyphenolics or phenolic-protein complexes once formed, and further tests focused on the sulfhydryl compounds effective in such inhibition.

Both 2-mercaptoethanol and 2-mercaptoacetic acid effectively prevented color formation in sugarbeet brei extracts, but after filtration through Whatman No. 1 paper, the resulting extracts were still too turbid for accurate OD or polarimeter reading. Laboratory techniques such as high speed centrifugation or membrane filtration could remove the turbidity, but a more satisfactory procedure for routine laboratory analysis was filtration through Whatman GF/A glass fiber filters. A test of 2-mercaptoacetic acid as the extracting solution, followed by filtration through GF/A, was made in comparison with our normal polarimetric sucrose clarificant, aluminum chloride. Twenty sugarbeet brei samples (from an experiment involving 100 days of storage prior to analysis), each representing a composite of the roots from a 7 m row, were analyzed in duplicate. Brei was hand mixed until

it was completely uniform and homogeneous in appearance, then duplicate samples were withdrawn. One was clarified by addition of aluminum chloride (1.0 g/L; added by proportioning balance in the ratio 177 ml solution : 26 g brei)), blending, and filtration through Whatman No. 1, whereas the other sample was clarified by addition of 2-mercaptoacetic acid (0.1% v/v aq., added in the ratio 177 ml solution : 26 g brei, quantities of brei and of solution determined by weighing) and filtration through GF/A filter paper. The latter samples will be called "MAA-clarified" (for 2-mercaptoacetic acid) in the following discussion.

MAA samples were clear and colorless and to the eye were not appreciably different in appearance from control (Al-clarified) samples. Color, as judged by OD at 420 nm in a 1 cm pathlength cell, was slightly lower (mean OD < 0.03) for MAA samples than normal samples (mean OD < 0.04); the difference is insignificant and probably related to slight residual turbidity in each sample type.

The two extract types were equally satisfactory for polarimetric reading by means of a 20 mm pathlength automatic polarimeter; final readings were reached rapidly and were stable. The mean polarimetrically determined sucrose content of the MAA samples was slightly higher than that of the controls (Table 1), with a statistically significant difference by paired t-test. An examination of duplicate sample pairs shows that most sucrose

Table 1. Sucrose content (as % of root fresh wt) for aluminum-clarified and 2-mercaptoacetic acid (MAA) clarified sugarbeet samples.

Sample	Al-clarif.	MAA-clarif.	Difference (MAA - Al)
1	12.18	12.34	0.16
2	12.95	12.76	-0.19
3	11.41	22.50	0.09
4	13.99	14.21	0.22
5	12.73	13.19	0.46
6	9.81	9.94	0.13
7	9.97	10.11	0.14
8	12.78	13.54	0.77
9	12.75	12.74	-0.01
10	12.81	12.99	0.18
11	11.71	11.77	0.06
12	12.98	13.11	0.13
13	11.99	12.15	0.16
14	11.89	11.39	-0.50
15	12.09	12.21	0.12
16	11.12	11.22	0.10
17	12.76	12.95	0.19
18	10.33	10.47	0.14
19	12.86	13.08	0.22
20	13.57	13.65	0.08
Mean	12.13	12.27	

determinations were within 0.2 (as % of beet fresh weight), but a much higher discrepancy occurred for several pairs (e.g., sample 8). Lack of adequate homogenization of the initial composite brei sample (i.e, actual difference in sucrose content of the material sampled), unrecognized effects of turbidity or color, or several other explanations could be advanced, but the actual cause of these differences is not known. This comparison was intended only as a preliminary exploration; much further work would be required to explore the actual relationship between the two extract types.

To examine the two clarification methods further, sodium, potassium, and amino nitrogen were determined in the sucrose filtrates from the duplicate samples above (Table 2). Sodium and potassium were determined by flame photometry with a lithium internal standard and amino N was determined

Table 2. Summary of sucrose (% of root fr wt) and of sodium, potasssium, and amino N concentrations (mg/100 ml) in paired samples clarified by 2-mercaptoacetic acid (2-MAA) or aluminum chloride (Al).

	Clarificant					
	Aluminum		2-MAA		Correl. Coeff.	Paired sample
Compound	mean	s.d.	mean	s.d.	r	t-test
Sucrose	12.13	1.14	12.27	1.19	0.981	2.50*
Sodium	5.19	2.54	5.56	2.47	0.968	2.58*
Potassium	14.22	2.76	14.26	3.09	0.971	0.26 ns
Amino N	1.94	1.15	2.99	1.30	0.991	21.9**

spectrophotometrically at 570 nm by the ninhydrin procedure. Potassium contents of the paired MAA clarified and aluminum clarified samples (Figure 1) were highly correlated (r = 0.971) and did not differ significantly (Table 2). In contrast, sodium (Figure 2) and amino N (Figure 3) concentrations each were significantly higher in the MAA clarified samples (Table 2), although correlation coefficients between the two extract types were high. The two extract types were equally suitable for flame photometric analysis, but the MAA samples did not give a typical blue-violet colored product with ninhydrin in the amino N analysis; instead the reaction product was a brownish- or grayish-blue. This color difference may be involved in the higher absorbance and thus higher amino N values of the MAA samples. In this preliminary exploration, no spectral analysis of the MAA-ninhydrin reaction was made, and no attempt was made to modify the standard analysis to the MAA clarified samples.

A 2-mercaptoacetic acid solution at 0.01% v/v (aq.) concentration was not satisfactory for clarification, leaving the GF/A filtered extract too turbid and in some cases colored. Additional tests of 0.1% 2-MAA in conjunction with other clarificants are still in progress.

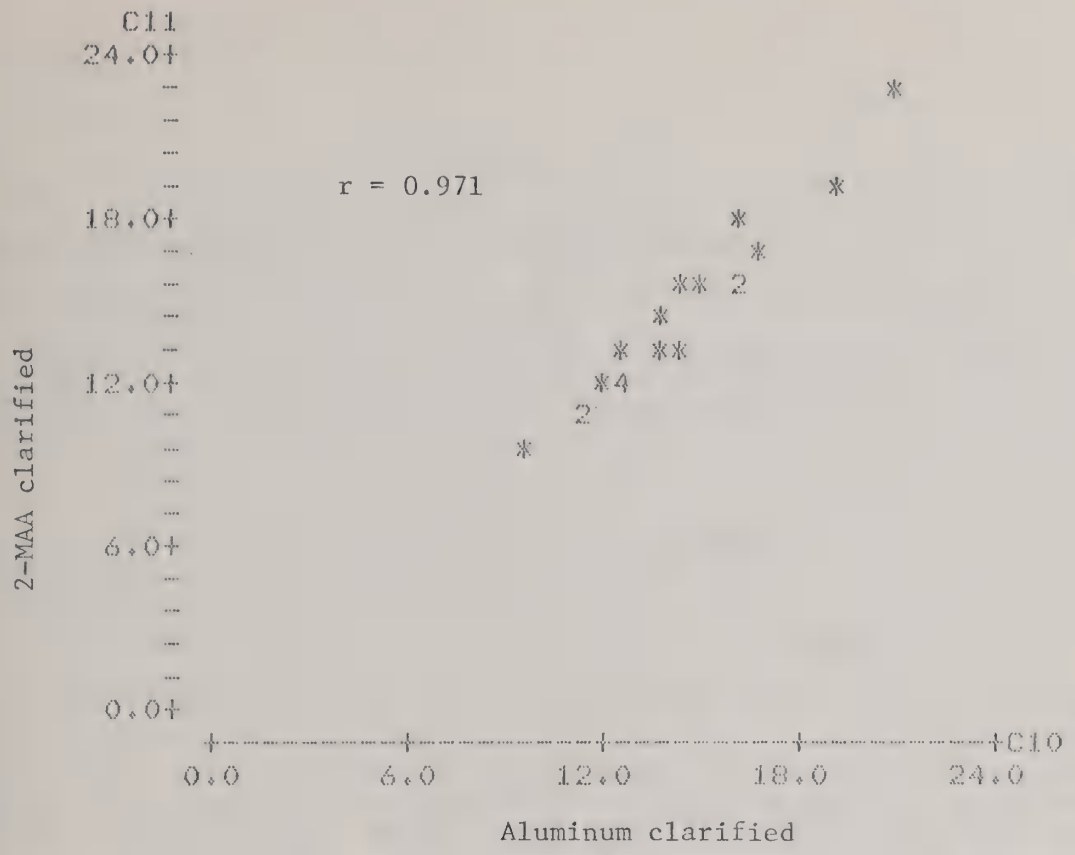

Figure 1. Potassium concentration (mg/100 ml) in paired sucrose filtrate samples clarified by 2-MAA (ordinate) vs. aluminum chloride (abscissa). Numerals indicate the number of data points plotting at the same locus.

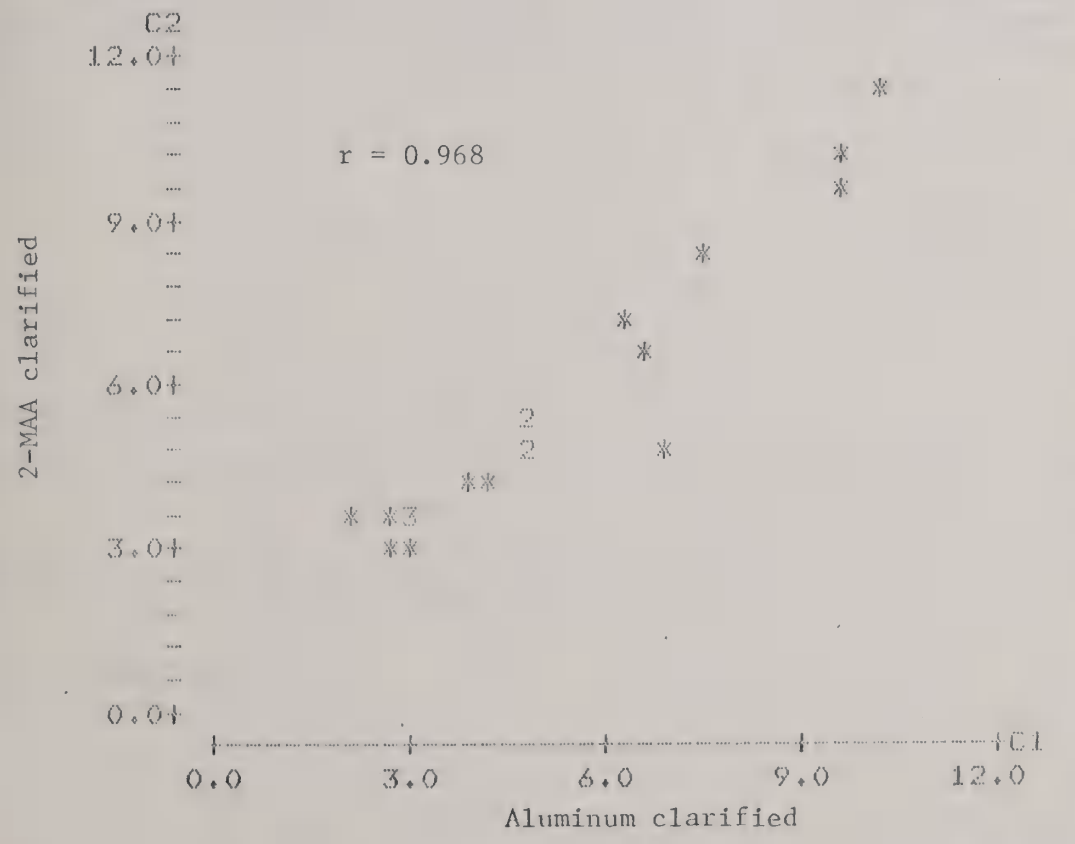

Figure 2. Sodium concentration (mg/100 ml) in paired sucrose filtrate samples

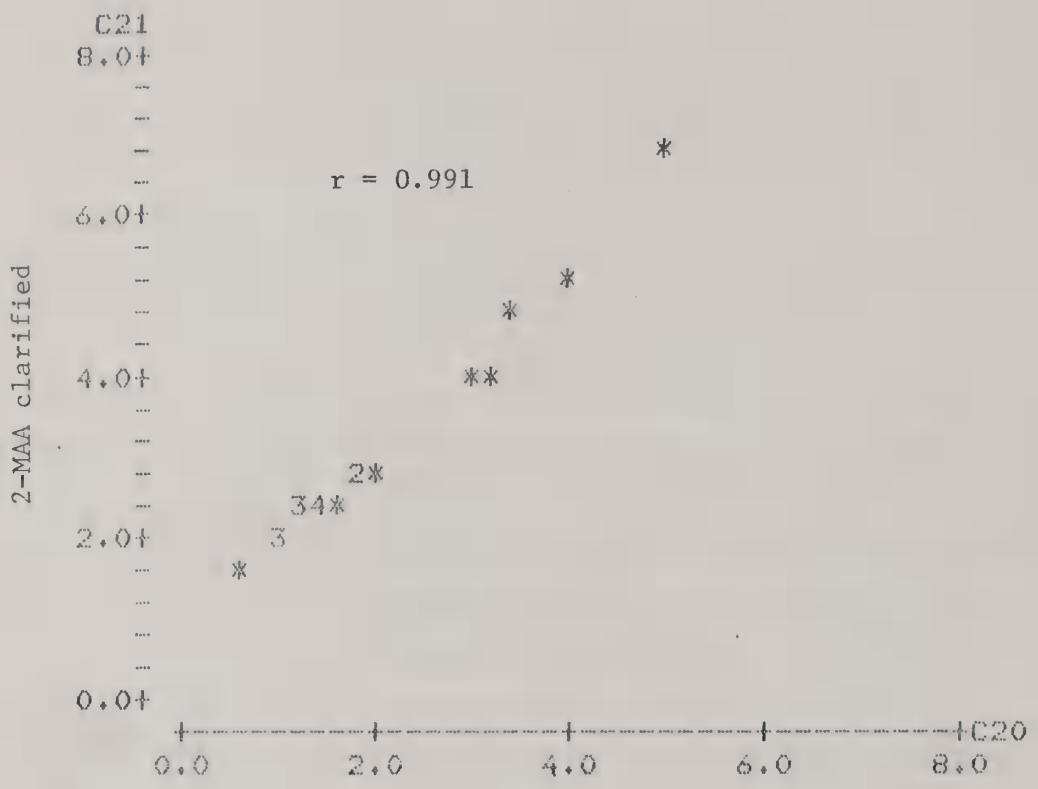

Figure 3. Amino N concentration (mg/100 ml) in paired sucrose filtrate samples clarified by 2-MAA (ordinate) vs. aluminum chloride (abscissa). Numerals indicate the number of data points plotting at the same locus.

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OTHER RESEARCH OF INTEREST TO BSDF MEMBERS

Self Incompatibility and Seed Production--G. A. Smith

Sufficient seed increases of breeding lines that exhibit self incompatibility or self sterility are difficult to obtain. Experienced breeders are aware that some small amounts of seed can sometimes be obtained under bags, but that seed yield and quality are inconsistent at best. References to increased seed production of normally self-incompatible plants at high elevation have been made.

With the increased use of clonally-propagated plants from tissue culture, the problem of self incompatibility may become even more critical. For example, a clonal family of plants developed for a specific trait may need to produce large quantities of seed for use in synthesizing a commercial hybrid.

This report describes the effects of elevation (location) on the seed production and quality from seed produced by a set of in vitro-produced clones. Ten clones, each represented by 20 genetically identical copies and all classed as self-sterile, were evaluated at five locations and four different elevations. Elevations ranged from about 1 meter below sea level at Rilland, The Netherlands, to 1900 meters in the mountains north of Masonville, Colorado. The 20 copies (ramets) from each clone were divided into groups of four ramets each and planted at each of the five locations as presented in Table 1. Prior to flowering, white canvas tents were placed over the four bolting plants (except at the Netherlands Greenhouse location). The plants were periodically checked for pollen production and agitated. All plants produced abundant pollen. Seed germination tests were conducted on seed that had been polished and processed over a gravity table. Results presented in Table 1 are for the better fraction of seed from the gravity table.

Table 1. Average per plant seed production, germination % and ranges for 10 self-sterile clones grown at five locations.

Location	Elevation (meters)	$\bar{x}$ Seed wt. (g)	Seed wt. range (g)	Germination 7-day %	Germination range %
Masonville, Colo	1900	143.4	37-233	51.2	18-71
Ft. Collins, Colo	1540	121.0	40-186	23.2	9-42
Italy	600	18.5	4.33	11.6	0-37
Netherlands, Field	1	20.6	4.42	5.5	0-18
Netherlands, Greenhouse	1	7.3	1-29	23.3	8-83

Quality and quantity of seed were greatest at the higher elevation locations. This fact is more significant since material at all locations was genetically identical. Obviously, the increased seed production and quality cannot be attributed solely to increased elevation. Factors such as light and temperature also may have some effect. All of these factors are measurable and can be artificially duplicated, albeit on a limited scale and at considerable expense. This study supports other reports, mostly unpublished, suggesting increased seed production at higher elevation. Practical implications include seed increase of self-sterile lines produced via in vitro cloning. High elevation seed increases of self-sterile clones may provide an inexpensive alternative when sizable quantities of seed are needed.

SUGARBEET RESEARCH

1983 Report

Section D

North Dakota Agricultural Experiment Station, Fargo, North Dakota

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Cooperation:

American Crystal Sugar Company
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
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PHYSIOLOGICAL GENETICS

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Research efforts over the past few years have been directed to the elucidation and evaluation of physiological and/or morphological parameters that can be easily measured in the seedling stage which indirectly measure cell size and cell division rate. If genetic variation in these two cell parameters can be identified in the seedling stage, then positive inferences can be made about the yield and sucrose potential of each given genotype. Research this past year entailed the investigation and partial development of one new greenhouse selection technique and the evaluation of three seedling selection techniques in replicated field trials. Because of personnel redirections and facility limitations, the overall research effort this past year was less than that of previous years.

Sucrose Concentration in Sugarbeet Seedlings

Earlier research efforts have been devoted to the evaluation of seedling cellular parameters with harvest root yield and harvest sucrose concentrations. Investigations of other seedling parameters (osmotic pressure, soluble solids, dry matter, etc.), have suggested a need to investigate sucrose accumulation patterns in very young beets.

Sucrose analysis was made on plants, 28-49 days post-planting, grown in small containers under controlled nutrition conditions. Limited nitrogen nutrition the last week of growth prior to sucrose analysis resulted in higher sucrose concentrations. Approximately 30 plants of each cultivar were used for each study. Several plants were combined to make approximately 10 grams of plant material for each analysis. This resulted in unequal replication, therefore, the experimental design was a CRD.

At 28 days post-planting (continuous light) the mean plant root weight was around 1 gram (Table 1). The sucrose concentrations of a series of cultivars with a very wide range in potential varied signficantly, but did not exhibit the wide range in concentration that they normally do at harvest time nor did they rank in the same order as at harvest time (Table 1). The ranking of the cultivars for sucrose concentration at 28 days post-planting showed some relationship with their ranking at harvest time, however, there were some notable miss-ranking, ex: Cultivar L19, ranked 2nd, has significantly higher sucrose potential than any of the cultivars in the test, and monovigor, a fodder beet, had a significantly higher sucrose concentration than some of the sugarbeet cultivars. It was noted that even though there was no significant correlation between root weight and sucrose concentration among cultivars (Table 1), there was a positive correlation within cultivars.

Table 1. Sucrose percentage and root weight for 12 cultivars with a wide range in potential sucrose at 28 days post-planting

	Sucrose %	Root weight g/plant
GW149	7.96	1.23
L19	7.84	0.66
US22/3	7.60	1.07
Beta 9421	7.32	1.14
USH 11	7.24	1.20
AH14	7.20	1.45
Monovigor	6.76	1.23
C17	6.36	1.01
Hilleshog 309	5.96	1.51
L10	5.96	1.10
Monorosa	5.68	1.39
Cammobarries	5.40	1.08
LSD 0.05	0.36	0.17

r (% sucrose vs root wt) = -.32 NS

This led to the evaluation of this correlation within cultiars over time. Table 2 gives the correlation between root weight and sucrose

Table 2. Root weight and correlation's between sucrose percentage and root weight for cultivar GW 149 at four different dates post-planting.

Age days - post-planting	Root weight g/plant	Correlation (r) between % sucrose and root wt.
28	0.93	0.91 *
35	1.47	0.99 **
42	3.04	0.72 NS
49	3.78	-0.64 NS

concentration for cultivar GW149 at 28, 35, 42, and 49 days post-planting. There was a highly significant positive correlation early, until the roots were 2-3 grams in size, or about 35-40 days post-planting, after which the correlation decreased and became negative (Table 2). This change from a positive to a negative correlation between root weight and sucrose percentage occurs at about the same time that differentiation in the root is completed. We hypothesized that while the root was still differentiating, sucrose concentration is a function of physiological maturity, but once the cambial rings are formed (root size of 2-3 grams) growth is by cell division and cell expansion, and the true relationship between cell size and sucrose concentration begins to emerge. Prior to that time, storage cells are of insufficient size to exhibit this relationship.

An additional test was conducted at 35 days post-planting on most of the same cultivars reported in table 1 (Table 3). Roots were larger (1.5 - 2.0 grows/plant) and the sucrose concentrations higher. The relationship

Table 3. Root weights, sucrose percentages, correlations (between root weight and sucrose percentage) and sucrose percentages adjusted for root weight for nine cultivars at 35 days post-planting.

	Root Wt	Sucrose	Correlation Between % Sucrose and Root Wt	Adjusted* Sucrose
	g/plant	%	within line	%
L19	0.94	10.2	0.96	13.1
GW149	1.95	11.6	0.99	11.7
Beta 9421	1.84	11.1	0.99	11.2
AH 14	1.62	10.5	0.98	11.1
Hilleshog 309	1.66	10.0	0.90	10.7
US22/3	1.47	10.0	0.98	10.9
USH11	1.81	10.2	0.97	10.4
Monovigor	2.16	9.8	0.82	9.7
Cammobaries	1.52	8.8	0.82	9.1
LSD 0.05	0.23	0.7		0.6

* Adjusted for root weight based on regression line between root weight and sucrose percentage.

among cultivars for sucrose concentration at this stage and at harvest time was closer, however, there were some cultivars that were still improperly ranked. A significant correlation between root weight and sucrose concentration was obtained within each line. By adjusting the sucrose concentration for root weight, based on the regression line between root weight and sucrose percentage within that cultivar, a much better relationship was achieved between the ranking of cultivars and their potential sucrose.

Selections were made for root weight and sucrose percentage among paired crosses within two heterogenous populations (g237 and g241). Paired crosses were evaluated by growing about 30 plants of each paired cross in the greenhouse under carefully controlled conditions for 40 days post-planting. Selections were based on root weight and sucrose percentage (adjusted for root weight as explained above). Sufficient remnant seed were available to test a high total sucrose and a high sucrose percentage selection from each population in a replicated field trial in 1983. The high total sucrose selection in each population gave a higher root yield (but not significant), equal sucrose concentration, and higher total sucrose yield (but not signficant) than their respective parent (Table 4). The high % sucrose selections gave lower root yields, higher sucrose percentages (but not significant) and lower total sucrose yields than their respective parents (Table 4). Even though differences were not quite signficant at $p = 0.05$, the differences between the selections and the parent populations were in the expected direction in both selections of each population. These preliminary results are sufficiently positive to warrant a more extensive investigation of this seedling selection procedure.

Table 4. Total sucrose, fresh root and root dry matter yields and sucrose and root dry matter percentages for populations g237 and g241 and on high sucrose* and high % sucrose* selection from each population.

	Total Sucrose lbs/A	Root Yield T/A	Sucrose %	Dry Matter %	Dry Matter Yield lbs/A
High total sugar sel.	4767	20.4	11.6	17.4	7145
High % sugar sel.	3996	16.8	11.9	18.5	6218
Parent (g237)	4551	19.3	11.8	17.9	6901
High total sugar sel.	4649	24.0	9.7	15.3	7368
High % sugar sel.	4207	21.3	9.9	15.4	6562
Percent (g241)	4267	22.7	9.4	15.3	6956
LSD 0.05	609	2.4	0.5	0.8	912
High total sugar sel.	4708	22.2	10.6	16.3	7256
High % sugar sel.	4102	19.0	10.9	17.0	6390
Parents ($\bar{x}$ of g237 & g241)	4409	21.0	10.6	16.6	6928
LSD 0.05	423	1.7	0.4	0.6	634

* Selections based on root weight and sucrose percentage (adjusted for root weight) of greenhouse grown plants, 40 days post-planting.

Stress Selection

One of the most difficult tasks of the plant breeder is to identify true genotypic differences. This is especially difficult for vigor or growth factors, since there are so many genes and metabolic functions involved, interacting with each other and with all kinds of environmental influences. In an attempt to identify true difference and eliminate environment and stress factors, plant breeders have developed selection schemes where plants are grown under ideal conditions. One such example is space planting beets to eliminate the competitional stress factors. Attempts to select for vigor under ideal conditions have met with little success. Environmental interactions have been so large that true genetic differences have been unidentifiable. Either the environmental interactions must be eliminated or genetic differences must be increased. However, stress might be used as a method of increasing genetic differences. Under extreme stress the more vigorous genotypes will survive and show less detrimental effects than the less vigorous genotypes and thereby magnify their true genetic differences.

This study was designed to evaluate the effectiveness of selection under extreme stress. Plants were grown in the greenhouse under controlled conditions to the four true leaf stage before imposing stress. Stress was imposed by trimming off the leaves, covering the trimmed plants with black plastic to eliminate photosynthesis and maintaining good growing temperatures. This forced the plants to immobilize their stored sucrose to produce more leaves. Plants with little stored sucrose died. Surviving

plants (about 25%) were saved for seed production to produce the new selection population. Selections were made in two heterogenous populations (g237 and g241). The new selection populations and the parent populations were tested in a replicated field trial.

In both populations, the new stress selection populations gave higher sucrose percentages, higher root yields and higher total sucrose yields than the parent populations (Table 5), however, none were significant at

Table 5. Total sucrose, root and root dry matter yield, and sucrose and dry matter percentages for populations g237 and g241 and stress selections from each population.

	Total Sucrose lbs/A	Root Yield T/A	Sucrose %	Dry Matter %	Dry Matter Yield lbs/A
Stress selection	5100	21.2	12.1	18.1	7654
Parent (g237)	4551	19.3	11.8	17.9	6901
Stress selection	4610	23.9	9.8	15.5	7334
Parent (g241)	4267	22.7	9.4	15.3	6956
LSD 0.05	609	2.3	0.5	0.7	920
$\bar{x}$ of stress sel.	4855	22.6	11.0	16.8	7494
$\bar{x}$ of parents	4408	21.0	10.6	16.6	6928
LSD 0.05	423	1.7	0.4	0.6	634

the 5% probability level. By combining the data, the new selections yielded significantly more sucrose and gave a significantly higher sucrose percentage than the parents. These data, although preliminary, suggest that this type of stress may be valuable in quickly identifying superior genetic deviates for vigor. Additional studies are necessary, however, to verify the above results.

Seedling % dry weight

This is the third and final year of evaluation of this seedling selection parameter. The rational for this parameter is based on the theory that the % dry matter in the seedling root is essentially cell wall material and correlates with cell size which in turn means sucrose concentration. Earlier tests have given mixed results, in that selection for high % dry matter in the seedling root has resulted in higher sucrose concentrations at harvest time in only about half of the selections. This inconsistant result may be due to either the inability to identify true genetic deviates because of high environmental influences or the confounding effects of other non-fiber dry matter materials in the seedling root. Results to date suggest that both of the above factors are contributing to our inability to consistently select superior genotypes for sucrose concentration.

Selections for high and low % dry matter in seedling roots from three different broad genetic populations were tested in replicated field trials (Table 6). The high seedling % dry matter selections gave higher sucrose

Table 6. Harvest total sucrose, root and root dry matter yields, and sucrose and root dry matter concentrations of seedling selections for root high and low % dry matter in three populations.

Seedling Selections	Total Sucrose lbs/A	Root Yield T/A	Sucrose %	Dry Matter %	Dry Matter Yield lbs/A
High % dry matter	4628	19.5	11.9	19.0	7365
Low % dry matter	4302	19.6	11.0	18.1	7079
Parent (h537)	4280	20.0	10.7	17.4	6946
LSD 0.05	443	1.6	0.6	0.7	667
High % dry matter	3675	17.6	10.5	16.9	5940
Low % dry matter	3815	18.7	10.2	16.8	6276
LSD 0.05	307	1.6	0.5	0.6	508
High % dry matter	4400	20.7	10.7	17.1	7086
Parent (L537)	4305	23.1	9.4	15.8	7278
LSD 0.05	493	2.6	0.8	1.0	848

percentages, lower root yields and with total sugar yields higher in one and lower in the other population than the low % dry matter selections. Differences, however, were significant only for % sucrose in the h537 population. In the two populations where the parents were available, the high % seedling dry matter selection gave a significantly higher sucrose concentration than the parent. In the L537 population the high % dry matter selection yielded significantly less than the parent with total sucrose yields about the same. Root yield for the high % dry matter selection from the h537 population was lower but not significant, resulting in a close to significant increase in total sucrose yield of the selection over the parent. Harvest root % dry matter and root dry matter yield gave the same relative relationships as the sucrose concentrations and total sucrose yields. These data suggest that the seedling root % dry matter is correlated with sucrose concentration at harvest time, however, we do not recommend this technique as a breeding tool because of its inconsistancy in identifying superior sugar genotypes.

Seedling Root Weight

Selections were made for seedling root yield in three heterogenous populations based on progeny performance in carefully controlled greenhouse conditions. Root weights were taken at 28 days post-planting. Seed was produced of the selected lines in open-pollinated seed isolation tents. The resulting seed was tested in replicated field tests this past summer. The results are given in Table 7.

Table 7. Harvest total sucrose, fresh root and dry root matter yield, and sucrose and root dry matter concentrations for seedling root yield (28 days post-planting) in three heterogenous populations.

Seedling Selection	Total Sucrose lbs/A	Root Yield T/A	Sucrose %	Dry Matter %	Dry Matter Yield lbs/A
High root yield	4759	21.3	11.1	18.2	7724
Mean root yield	4376	18.5	11.2	18.3	7141
Parent (h537)	4280	20.0	10.7	17.4	6946
LSD 0.05	440	1.6	0.7	0.8	667
High root yield	3800	19.2	10.1	17.0	6346
Mean root yield	3722	18.0	10.3	17.0	6009
LSD 0.05	307	1.6	0.5	0.6	508
Highest root yield	4091	23.2	8.8	15.9	7385
	4002	22.6	8.9	15.5	6957
	4222	21.9	9.6	16.2	7124
	3218	17.2	9.4	16.2	5566
Lowest root yield	3695	18.9	9.9	16.5	6214
Parent (L537)	4305	23.1	9.4	15.8	7278
LSD 0.05	493	2.6	0.8	1.0	848

The high seedling root yield selection from population h537 was higher, but not significantly, in sucrose percentage and root yield, than the parent and yielded significantly more sucrose than the parent. The mean root yield selection was not different from the parent. There were no differences in total sucrose yield, root yield and sucrose percentage between the high seedling root yield and the mean root yield selections for the population in which seed was not available of the parent for comparison (Table 7). In population L537, a continuous range of selections were made for root yield. The harvest root yield of these selections followed the seedling root yield ranking relatively close. The sucrose concentrations of these selections was the reverse of the root yield rankings, i.e., the highest root yield selection had the lowest sucrose percentage and the lowest root yield selection had the highest sucrose percentage. This resulted in little difference in total sucrose yield between the selections and the parent. These results demonstrate the inverse relationship between root yield and sucrose concentration and the difficulty of increasing total sucrose yield by selecting for only one of the two parameters. Earlier studies would suggest that our selection pressure was for additive type genes (cell size) in population L537 and for non-additive type genes (cell number) in population h537). Root dry matter percentages and root dry matter yields were similar to the sucrose percentages and total sucrose yields, respectively.

Seedling Fiber Concentration

Earlier studies have suggested that the difficulties in selecting for potential sucrose by selecting for seedling root % dry matter might be due to the varying concentrations of non-sucrose osmolites in young roots. Since cell wall material constitute the majority of the root fiber, we theorized that root fiber content should give a relative measure of cell size and ultimately sucrose potential. Preliminary studies for seedling fiber content gave better correlations with potential sucrose than seedling % dry matter.

Selections for seedling fiber content were tested in a replicated field trial in FY 83. The same selections were tested for sucrose concentration in replicated greenhouse experiments. In the greenhouse experiments, sucrose was determined in 40 day-old plants. The high % fiber selection gave a significantly higher sucrose concentration than the parent in the greenhouse experiment (Table 8). However, when these selections

Table 8. Harvest total sucorse, root and root dry matter yields and sucrose and root dry matter percentages of selections made for seedling fiber concentrations.

Seedling Selection (root)	Total Sucrose lbs/A	Root Yield T/A	Green house Sucrose %	Sucrose %	Dry Matter %	Dry Matter Yield lbs/A
High fiber %	4040	22.1	105	9.3	15.0	6568
Low fiber %	4176	22.2	96	9.4	15.3	6790
Parent (m167)	4311	23.4	100	9.3	14.4	6710
LSD 0.05	556	2.2	3	0.8	0.9	830

were tested in the field, there was no difference in sucrose concentration, root yield or total sucrose yield between either selection and the parent. Further testing is essential to verify the merits of this seedling selection parameter.

THE DEVELOPMENT AND EVALUATION OF FUEL-TYPE BEETS FOR ETHANOL PRODUCTION

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"Fuel Beet" Breeding

Initial selections in a broadbase genetic population produced one new population (g241) that shows significant promise as germplasm for continued investigation. With minimal selection pressure for total sugar yield, this population gives equivalent total sugar yields to some of the best adapted sugarbeet hybrids. This population is extremely heterozygous, suggesting that continued progress is possible.

Selection for "fuel beets" is different than for "sugarbeets." Beets for sucrose crystalization purposes require high sugar concentrations and low concentrations of amino nitrogen, whereas, sugar concentrations are unimportant for fuel type beets and high amino nitrogen concentrations are beneficial. Therefore, selection schemes used in sugarbeet breeding programs may not be desirable or effective in a "fuel beet" breeding program.

Selections were made in population g241 under three different seedling selection schemes. These seedling selection schemes are designed to identify high sucrose, high root yield, and high total sugar yield potentials in the seedling stage. Identification of these potential superior genotypes in the seedling stage significantly accelerates the selection process. Following seed production, these selections were tested under replicated field conditions this past year.

High fiber content in the seedling stage has been shown to be correlated with sucrose content at harvest time. Several selections for seedling high fiber content were evaluated in replicated field trials. The high seedling fiber content selections gave higher sugar concentrations than the parent (g241) population, however, all selections were lower in root yield than the parent. This result is often observed when selection is just for sugar concentration. The total sugar yields were, therefore, no different from the parent (g241). This selection scheme, although effective for increasing sugar concentration, is not effective for "fuel beet" selection purposes.

Two other seedling selection schemes: 1) seedling total sugar yield, and 2) dark stress selection, gave promising results and appear to be useful in a "fuel beet" breeding program. Seedling total sugar yield was calculated in beets four to five weeks of age from sucrose concentration and root weight measurements. Extreme control of environmetal effects is essential to be able to measure true genetic differences at this young age. Dark stress selection is a quick and simple method of determining the effectiveness of a given genotype to produce and store sugar rapidly at a young age. This was measured in three-week-old seedlings by forcing the

young seedlings to immobilize their stored sugar for leaf production and survival. Both high total sugar and dark stress selections gave higher root yields, higher sugar concentrations, and higher total sugar yields than the parent g241 (Tables 4 and 5). These increases were, however, not significant at the five percent probability level but were approaching it. Again selection for high percent sugar, even though increasing sugar content, reduced root yield and resulted in no change in the overall total sugar yield. These data show promise and suggest that continued progress is possible using the seedling total sugar yield and dark stress selection schemes.

Population Development for "Fuel Beet" Breeding

Maintaining high sugar concentrations and low concentrations of nitrogen, sodium, and potassium are essential in a sugarbeet breeding program. These essential quality parameters, therefore, restrict the germplasm in a sugarbeet breeding program and reduce the genetic base of commercial sugarbeet hybrids. In a "fuel beet" breeding program, these quality parameters are unimportant. This means that the germplasm in a fuel beet breeding program can be much broader including many wild and exotic types. By broadening the genetic base, greater genetic diversity is created resulting in greater potential heterosis.

A new broad base genetic population consisting of a wide range of genotypes from both sugarbeet and fodder beet lines was initiated in 1982. Seed from the first open-pollinated polycross was obtained in 1983. In order to allow for greater recombination to take place, several open-pollinated cycles must be achieved. The second cycle polycross will be initiated in FY 84.

Partial purification and properties of an invertase from Pseudomonas fluorescens

W. M. Bugbee

Sugarbeet roots contain an endophytic population of sucrose hydrolyzing bacteria. It is not known if these bacteria utilize the roots' sucrose while the roots are being stored. Purification and characterization of bacterial sucrose hydrolase is an essential step in assessing the role of microbes in sucrose degradation in stored roots. A step in this direction was taken with a sugarbeet root isolate of Pseudomonas fluorescens and the results are reported here.

The Pseudomonas fluorescens used was isolated from internal tissues of a healthy sugarbeet root that had been stored at 4-6° and 95-98% relative humidity for 100 days. The bacterium was maintained on nutrient agar slants amended with 2% sucrose and increased in a broth of: 0.02 M potassium phosphate buffer (KPB) pH 7.2, 0.3 g yeast extract, 0.2 g $MgSO_4.7H_2O$, 1 g $(NH_4)_2HPO_4$, 20 g sucrose and 1 l distilled water. One l of broth was placed in each of six 2-l flasks and shaken at 23-25°. The bacteria were harvested at 48 hr by centrifugation. The pellet was washed once in 100 ml of 0.02 M KPB pH 7.2.

Bacteria (46 g wet weight) were extracted at room temperature by mixing for 30 min with 11.5 ml of glycerol, 0.46 ml of TRITON X-100, 46 µl 2-mercaptoethanol then adding 136 ml of 0.2 M KPB pH 7.2, 0.3 ml 1 mM EDTA, 10 mg phenylmethylsulfonylflouride, 20 µg DNase from bovine pancreas, and 25 mg lysozyme. The mixture was incubated overnight at room temperature. The remaining procedures were done at 4-6° C. The mixture was centrifuged at 5000 x g for 30 min and the supernatant was saved. A neutralized solution of protamine sulfate at 5 mg g^{-1} of bacteria was added and mixed for 30 min to precipitate nucleic acids. The precipitate was removed by centrifugation and discarded. The extract was dialyzed overnight against 6 l of 0.02 M Tris-HCl pH 7.2 containing 0.2M NaCl and then concentrated to 8-10 ml by dialysis against solid polyethylene glycol. The dialysate was centrifuged and the supernatant was applied in an ascending flow through a 2.6 x 42 cm column of Sephacryl 200 gel equilibrated and eluted with 20 mM Tris-HCl pH 8.2 plus 0.2 M NaCl. The most active fractions were dialyzed against 20 mM Tris-HCl then loaded onto an anion-exchange column 1.6 x 15 cm containing DEAE-Sepharose equilibrated with 20 mM Tris-HCl pH 8.2. Effluent was monitored at 280 nm. The column was eluted with a linear gradient of NaCl in start buffer after nonadsorbing proteins had eluted. The limit buffer was 0.5 M NaCl in start buffer. Fractions of 5 ml were collected and the flow rate was 24 ml hr^{-1}. Protein was precipitated with 80% ammonium sulfate from the most active fractions, centrifuged and the precipitate was redissolved in 2.5 ml of 20 mM KPB pH 7.2 and desalted by passing through a PD-10 disposable column of Sephadex G-25 or dialyzed against 1% glycine for isoelectric focusing.

Enzyme assay. The invertase assay mixtures contained 0.01 or 0.1 ml of enzyme solution, 0. ml of 0.75 M substrate and brought to 1 ml with 0.2 M KPM pH 6.5. The mixture was incubated 15 or 30 min at 30°. Enzyme activity was stopped by adding 1 ml of Somogyi's reagent and placing the mixtures in a boiling water bath. Invert sugars were measured by Nelson's

modified Somogyi method. A unit of enzyme activity was defined as that amount of enzyme which catalyzed the release of 1 mol of reducing sugar per min at 30°.

pH. The optimum pH for invertase activity was determined in a 0.2 M KPB pH series of 4.5 to 7.5 at 0.5 unit increments.

Molecular weight determination. The molecular weight of the partially purified native invertase was estimated on the Sephacryl 200 gel column that had been calibrated with the molecular weight standards: albumin (67,000), ovalbumin (44,000), chymotrypsinogen (25,000), and myoglobin (17,000). Fractions were 5 ml and the flow rate was 36 ml hr^{-1}.

Isoelectric focusing and PAGE-SDS. The desalted enzyme dissolved in 1% glycine was focused at 5° C in a 0.25 mm thick, 10% polyacrylamide gel for 2000 v.h at 30 w. The gel was bonded to a polyester film. The gel contained 2.5% ampholyte of pH 3.5-5.0. The ph gradient of the focused gel was measured at 1 cm intervals with a surface ph electrode at 5° C. The focused gel was fixed 30 min in 20% (w/v) trichloroacetic acid, stained 30 min in 1% (w/v) copper sulfate - 20% (v/v) acetic acid combined 1:1 with 0.3% (w/v) Coomassie Brillant Blue R-250 in 90% (v/v) methanol then destained in 1% (w/v) copper sulfate - 10% acetic acid and 25% methanol (v/v). A sample lane was cut from the gel-film before the fixing-staining procedures. The excised lane was treated to identify the invertase band. A 0.5% agarose suspension melted in assay buffer was applied to the excised gel and incubated at room temperature for 10 min. The gel strip with the solidified agarose-buffer was stained for fructose using triphenyltetrazolium chloride (TTC). The TTC treated gel was aligned with the Coomassie stained gel to confirm which band was invertase. The Coomassie stained invertase band was removed from the polyester film with a microspatula and treated for 30 min on a glass slide with 2-3 drops of 1% SDS (w/v) and 4% (v/v) 2-mercaptoethanol in a 40-fold dilution of tank buffer. The treated band then was placed in a shallow well of the stacking buffer and covered with a molten 1% agarose in 0.125 M Tris-HCl pH 6.8 and 1% SDS for PAGE-SDS. The 1.5 mm gel was a linear gradient of 6-30% polyacrylamide resolving gel and a 4% polyacrylamide stacking gel. Molecular weight standards were phosphorylase b (94,000), albumin (67,000), ovalbumin (43,000), carbonic anhydrase (30,000), trypsin inhibitor (20,100), and -lactalbumin (14,400). The protein bands were visualized using Coomassie brilliant blue R-250 followed by a Bio-Rad silver stain kit and protocol.

A lane also was treated with periodic acid and Shiffs reagent to detect glycoproteins.

Kinet[illegible] Invertase activity was measured in a sucrose concentration [illegible]s of 60 to 220 mM in 40 mM increments. The assay mixture was 1 [illegible] 0.2 M KPB at pH 6.5 containing sucrose and 10 µl of the purifi[illegible]zyme preparation. Incubation was at 30° for 15 min. Reducing sug[illegible]rs were measured as above.

Peak invertase activity eluted off the calibrated gel column in fraction 20 with an estimated molecular weight of 35,400 (Fig. 1). The protein consisted of two subunits with molecular weights of 19,000 and 21,000 as shown by PAGE-SDS. These weights contrast with 152,000 found for

Xanthomonas campestris pv. oryzae, a bacterial pathogen of rice, and compare with 55,000 for Bacillus subtilis and 48,000 for Streptococcus mutans. The invertase in the latter case was a single polypeptide chain. Therefore, the invertase reported here for P. fluorescens is the smallest of prokaryotic invertases reported to date.

Isoelectric focusing showed two major and several minor bands when stained with Coomassie brillant blue. One major band was the invertase as shown after incubation with buffered sucrose and staining with TTC. The invertase band focused at pH 4.18.

None of the bands in the IEF gel reacted with the PAS-Shiffs stain indicating that this invertase is not a glycoprotein.

The invertase eluted off the anion-exchange gel at 0.4 M NaCl. This relatively strong adsportive characteristic probably contributed to the 7.8 fold increase in specific activity that developed from this procedure (Fig. 2).

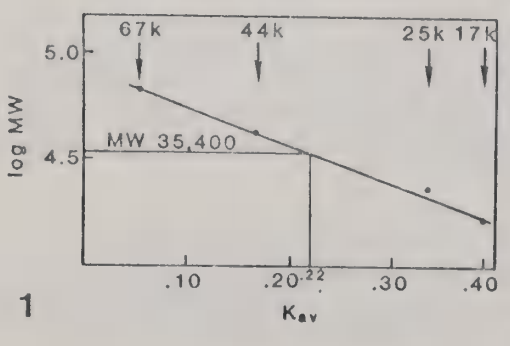
Invertase was most active at pH 6.5 when assayed in a KPB pH series of 4.5 to 7.5, therefore, this enzyme can be described as a neutral invertase. The same optimum pH was found for Clostridium pasteurianum in a KPB.

A K_m of 90 mM was measured when sucrose was used as the substrate. The K_m for C. pasteurianum was estimated at 79.5 mM of sucrose.

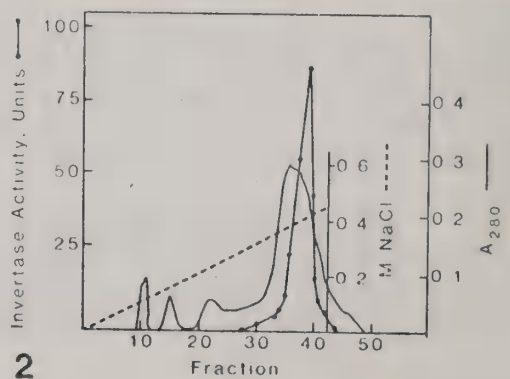
Assays of dialyzed culture filtrates and suspensions of P. fluorescens indicated very low invertase activity until the cells were lysed. Therefore, the invertase has an intracellular location.

Reducing sugars were present after the purified invertase was incubated with sucrose or raffinose but not maltose. This suggests the invertase is a β-fructofuranosidase, EC 3.2.1.26.

This research has shown that the sucrose hydrolyzing capability of a sugarbeet root isolate of P. fluorescens is due to an intracellular, dimeric β-fructofuranosidase with maximum activity at pH 6.5 in a phosphate buffer. The pH of sugarbeet roots is 6.5-7.2. Furthermore, endophytic sugarbeet root bacteria increased in numbers while roots were stored at 4-6° for 150 days. Therefore, it is probable, but not yet proven, that P. fluorescens and other endophytic root bacteria play a part in hydrolyzing the root's sucrose while the root is stored awaiting processing.



1



2

Endophytic bacteria. Of 35 randomly selected bacterial isolates from sugarbeet roots, only four produced extracellular sucrase when grown in a buffered sucrose broth. The isolates were Corynebacterium sepedonicum, Bacillus circulans, Pseudomonas marginalis, and an unknown isolate from Michigan beets. Corynebacterium sepedonicum is a pathogen of potato causing a disease called ring rot, a serious problem in the Red River Valley. Pathogenicity tests are planned to assess the significance of this finding. Characterization of the extracellular sucrase is in progress.

Abstracts and Manuscripts Published

1. Bugbee, W. M. 1983. Infection and movement of endophytic bacteria in sugarbeet plants. Phytopathology 73:806 (Abstract).

2. Bugbee, W. M. and H. Nashaar. 1983. A newly recognized symptom of sugarbeet root infection caused by Phoma betae. Plant Disease 67:101-102.

A METHOD TO ESTIMATE HARVEST LOSSES DUE TO TAPROOT BREAKAGE

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Sugarbeet root yields are often reduced due to root breakage which may occur below the soil surface when the roots are lifted or during the loading and piling of the roots. Cole and Seiler developed a model to estimate the amount of crown removed by scapling (Table 1). The model was based on the diameter of the cut surface of the crown. A model is needed to determine losses caused by breakage of the taproot.

Table 1. Estimates of the amount of crown removed by measurement of the cut surface of the crown at a right angle to the longitudinal root axis.*

Diameter	Crown loss	Diameter	Crown loss
inches	%	inches	%
0.25	<1.0	2.25	16.7
0.50	<1.0	2.50	24.0
0.75	<1.0	2.75	33.1
1.00	1.4	3.00	44.0
1.25	2.1	3.25	58.4
1.50	4.0	3.50	71.3
1.75	6.4	3.75	85.6
2.00	10.6	4.00	95.8

* From Cole, D. F. and G. J. Seiler. 1978. Regression techniques for estimating percent crown removed in scalping sugarbeet roots. J. Am. Soc. Sugar Beet Technol. 20:129-132.

Sugarbeet roots were manually harvested from yield experiments conducted by American Crystal Sugar Co. during 1982 and 1983. Ten consecutive beets within a row, excluding small beets and beets with sprangled roots, were harvested. Roots of 14 and 13 cultivars were selected in 1982 and 1983, respectively, from 6 locations each year.

Each root was washed and dried. The following measurements were made on each root: length, weight and circumference. The roots were sectioned into 5 segments below the lowest leaf scar by making 4 random cuts through the bottom one-half of the taproot. The length, weight, and diameter of each segment were determined. A cut was made through the center of the crown and at the lowest leaf scar, thereby dividing the crown into two segments. Each crown segment was measured in the same manner as the taproot segments.

Analysis of the data indicated that roots of Beta 1230 and ACH-14 were the largest and smallest, respectively, when averaged over all locations and years. The roots harvested from the Alvardo location in 1983 averaged 2.17 pounds compared to 1.41 pounds for roots harvested at the Moorhead location in 1982. The average weight of roots harvested in 1983 was 15% larger than those harvested in 1982.

Several variables were used to determine the best model to estimate losses due to root breakage. The best single variable model, based on plot means, was the ratio between the diameter of the broken surface of the taproot and the overall length. The best two variable model included the ratio and the circumference of the root. However, adding the second variable did not greatly improve the prediction model. An R^2 of 0.92 and 0.94 was obtained for the one and two variable models, respectively. Root losses can be estimated by measuring length and diameter of the sugarbeet root (Table 2). Analysis of the data indicated that cultivars and growing locations can influence the model. However, the combined model can provide a good estimate of the root losses due to breakage.

Table 2. Root losses as affected by root length and diameter of the taproot. Plot means were used to determine the model, loss = -3.8 + 32.3 (ratio). Ratio = $\frac{\text{diameter of taproot}}{\text{length}}$.

Length of taproot, inches	Diameter of broken surface of the taproot, inches											
	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	percent loss											
3.5	1	5	10	15	19	24	28	33	38	42	47	52
4.0	<1	4	8	12	16	20	24	28	32	37	41	45
4.5	<1	3	7	11	14	18	21	25	28	32	36	39
5.0		3	6	9	12	16	19	22	25	28	32	35
5.5		2	5	8	11	14	17	20	23	26	28	31
6.0		2	4	7	10	12	15	18	20	23	26	28
6.5		1	4	6	9	11	14	16	19	21	24	26
7.0		1	3	5	8	10	12	15	17	19	22	24
7.5		1	3	5	7	9	11	13	16	18	20	22
8.0		<1	2	4	6	8	10	12	14	16	18	20
8.5		<1	2	4	6	8	10	11	13	15	17	19
9.0			2	3	5	7	9	11	12	14	16	18
9.5			1	3	5	6	8	10	12	13	15	17
10.0			1	3	4	6	8	9	11	12	14	16
10.5			1	2	4	5	7	8	10	12	13	15
11.0			1	2	4	5	6	8	9	11	12	14
11.5			<1	2	3	5	6	7	9	10	12	13
12.0			<1	2	3	4	6	7	8	10	11	12
12.5				1	3	4	5	7	8	9	10	12
13.0				1	2	4	5	6	7	9	10	11
13.5				1	2	3	5	6	7	8	9	11
14.0				1	2	3	4	5	7	8	9	10

CHARACTERIZATION OF STORGE ROT RESISTANT GERMPLASM

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In the United States up to 75% of the sugarbeet crop is stored in large exposed piles for 30 to 150 days. During this time, various rot organisms grow on the root, consuming sucrose and producing compounds that interfere with crystallization of sucrose. Selection for resistance to three of the major storage rot fungi (Phoma betae, Botrytis cinerea, and Penicillium claviforme) has resulted in the development of rot resistant lines. Genetic resistance to storage rot fungi is intended to compliment other methods of reducing storage losses such as pile ventilation and reducing injury to roots. Three lines are being increased for possible release as rot resistant germplasm. These lines are intended to be used as pollinators for experimental hybrids, as parents in genetic studies, and as genetic sources for the development of storage rot resistant parental lines. The three lines have been designated F1004, F1005, and F1006.

F1004 is a multigerm line which resulted from 6 cycles of recurrent selection from VNIS F526, an introduction from the USSR. F1004 segregates for red and green hypocotyl color.

F1005 is a multigerm, green hypocotyl line resulting from five cycles of recurrent selection from VNIS F738, a USSR introduction. Original selection was for Botrytis resistance with selection for the resistance to the other two fungi occurring in later cycles.

F1006 is a multigerm, red hypocotyl line selected from a population formed by itnerpollinating rot resistant individuals from the world collection. The original parents had high levels of resistance to one rot organism and were at least slightly superior to the checks for resistance to the other two. Superior individuals were crossed in pairs for three subsequent generations. Individual pairs were maintained as lines in each cycle. Concurrent with selection for rot resistance, visual selection was used to eliminate lines with the tendency to produce sprangled roots and lines with colored roots.

All three lines have been evaluated in replicated field trials for at least three years. Storage rot response and agronomic data are summarized in Table 1.

These lines and others in the program will serve as a basis for further improvement. A rot resistant cytoplasmic male sterile line is being developed. Improvement in agronomic and quality characteristics is a continuing goal of the program. Inheritance and combining ability studies are needed to faciliate the use of these lines in an applied breeding program.

Table 1. Characteristics of three storage rot resistant germplasm lines, 1981-1983.

	Phoma	Botrytis	Penicillium	Sucrose	Purity	Yield	Stand
	rating *			%		Tons/A	plants/100 ft
F1004	1.4	1.6	1.4	11.6	82.3	13.4	89
F1005	1.2	1.6	1.2	10.8	80.5	15.3	101
F1006	1.2	1.6	1.1	11.5	81.2	14.5	82
Checks**	2.6	3.6	2.8	11.9	85.5	22.6	111

* Rot rating indicates the distance rot progressed through a 1 cm^3 block of rot tissue after incubation at 20 C for 2 weeks: 0 = 0 mm; 1 = not over 2 mm; 2 = 2-4 mm; 3 = 4-6 mm; 4 = 6-8 mm; 5 = entire block.

** Checks were not the same in all three years but included GW-R1, Beta 1345, Ultramono, Beta 1230, and Hilleshog 833.

SUGARBEET RESEARCH

1983 Report

Section E

Michigan Agricultural Experiment Station, East Lansing, Michigan

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HYBRID EVALUATIONS

G.J. Hogaboam, J.W. Saunders, J.C. Theurer and C.L. Schneider

Hybrids provided by Dr. G.E. Coe were evaluated at the B & B Farm for yield and quality and at the Muck Farm for leaf spot resistance. The performance of these are given in Table 1.

A computer print out of the leaf spot performance of USDA material in hybrids and of commercial hybrids evaluated at East Lansing and at Beltsville are given in Table 2.

We have just begun work to use and IBM PC XT to handle all of the record keeping needed in a sugarbeet breeding program. The software program MSTAT being developed here at Michigan State seems to be filling much of this need.

Papers published in 1983

DONEY, D.L. and THEURER, J.C. 1983. Genetics of cell size and sucrose concentration in sugarbeet. Crop Sci. 23:904-907.

GRIFFIN, G.D. and THEURER, J.C. 1983. The comparative response of sugarbeet and fodder beet to Heterodera schachtii. Jour. Nematology 15:140-141.

SAUNDERS, J.W. 1983. Rapid floral expression by sugarbeet seedlings under continuous incandescent lighting and moderate temperatures. Crop Sci. 23:592-593.

THEURER, J.C. 1983. Inheritance of feather leaf and plantain leaf characters in sugarbeet. (Accepted for publication in Crop Sci.)

SCHNEIDER, C.L. and SAFIR, G.R. 1982. Aerial photography evaluation of sugarbeet experimental plots with Rhizoctonia solani. Jour. of Amer. Soc. Sugar Beet Technol:20(4):374-382.

SCHNEIDER, C.L. and POTTER, H.S. 1983. Efficacy of some fungicides in controlling Rhizoctonia crown rot of sugarbeet. Jour. Amer. Soc. Sugar Beet Technol. 22(1):54-59.

Table 1. New hybrids performance at B & B Farm, East Lansing and Beltsville leaf spot nurseries.

0 -8 CMS PARENT
1 -8 O TYPE
2 -10 MALE PARENT or SEED NUMBER
4 4 RWS/A
5 4 T/A X10
6 3 RWS/T
7 4 % SUCROSE X 10
8 4 % C J PURITY X 100
9 2 E.L. LS X10
10 2 Belts LS X10

CASE NO.	0 0	0 1	0 2	0 4	0 5	0 6	0 7	0 8	0 9	1 0
37	USH20CMS	80576-0	76250-237	5561	215	258	155	9402	27	33
38	80320-01	80576-0	79260-0	5184	208	247	148	9392	27	40
39	USH20CMS	80576-0	79260-0	5058	199	253	152	9408	30	40
40			USH20	5034	199	251	150	9428	33	50
41	79564-01	80576-0	76250-237	4964	210	237	145	9309	23	30
42	80164X1		78260-0	4900	192	254	154	9354	27	33
43	80566-02	80576-0	79260-0	4892	198	246	148	9394	27	37
44	80566-02	80576-0	76250-237	4840	201	240	146	9326	30	37
45	79543-01	78756-0	76250-237	4815	192	248	149	9385	23	30
46	79626-01	78756-0	79260-0	4643	209	223	136	9315	30	40
47	80320-01		7822-0gr	4642	198	233	141	9359	30	40
48	80320-02	80576-0	76250-237	4605	191	241	147	9323	27	30
49	7542-01	78564-0	76250-237	4588	188	243	148	9345	23	30
50	FC607CMS	78564-0	79260-0	4563	181	249	149	9427	30	33
51	6926-01	78564-0	76250-237	4549	183	246	147	9417	27	33
52	79624-01	78756-0	79260-0	4535	188	241	146	9360	23	40
53	79626-01	78756-0g	82260-0	4494	195	228	139	9311	27	40
54	80320-01		82260-0	4441	186	236	144	9327	30	40
55	79626-01	78756-0g	7822-0gr	4405	184	238	145	9307	30	40
56			USH23	4397	175	250	148	9452	27	50
57	79624-01	78756-0	76250-237	4388	182	240	144	9404	30	30
58	79626-01		78260-0	4385	161	271	162	9400	27	33
59	FC607CMS	78564-0	76250-237	4374	179	243	146	9417	27	27
60	7542-01	78564-0	79260-0	4365	179	242	146	9358	30	33
61	80140X1		78260-0	4364	187	232	143	9289	27	33
62	1861	12166	79260-0	4284	167	255	151	9464	33	43
63	78576-01	78564-0	76250-237	4283	174	245	147	9403	23	27
64	78576-01	78564-0	79260-0	4234	168	250	148	9490	30	37
65	80576-01		79260-0	4227	168	249	147	9480	27	33
66	6926-01	78564-0	79260-0	4176	173	240	144	9394	30	37
67	79624-01	80576-0	79260-0	4110	167	246	149	9359	30	40
68	79624-01	80576-0	76250-237	4038	167	238	145	9319	23	30
69	79626-01	78756-0	76250-237	4032	174	231	141	9322	30	33
70	79564-01	80576-0	79260-0	4031	164	247	148	9402	30	37
71	80320-01		78260-0	4017	172	234	142	9357	30	43
72	79682-01	78756-0	76250-237	3999	182	225	136	9231	27	30

Table 2. Leaf spot performance of some USDA hybrids and of some commercial hybrids at East Lansing and Beltsville. Where available, the Aphanomyces score as % of susceptibility of USH20 is given.

0 -8 CMS PARENT
1 -8 O TYPE
2 -10 MALE PARENT or SEED NUMBER
9 2 E.L. LS X10
10 2 Belts LS X10
11 3 Aphan. % score

CASE NO.	0 0	0 1	0 2	0 9	1 0	1 1
498		80576-0	30	37		
499	FC607	6822-0	30	40	100	
500	564-01	7042-0	EL47	30	40	78
501	EL36	506TL	6822-0	33	40	89
502	79320-02	576	6822-0	33	40	90
503		MONOHYE4	33	40		
504	79320-01	576	6822-0	33	43	89
505	6926-01	EL45	EL47	33	47	101
506	EL44	EL45	EL40	33	47	
507	EL36	564-0	EL40	33	47	
508	80624-01	576	EL40	33	47	96
509	79320-01	576	EL40	33	47	90
510	79320-02	576	EL40	33	50	85
511	6926-01	EL45	EL40	33	57	
512	564-01	7042-0	EL40	37	40	
513	EL36	506TL	EL40	37	43	93
514	FC606	EL36	6822-0	37	43	115
515	USH20CMS	576	EL40	37	50	85
516	78641-01	EL45	6822-0	40	43	
517	EL44	EL45	EL47	40	47	93
518	576-01	EL45	EL40	40	50	
519	FC606	EL36	EL40	40	50	109
520	7542-01	EL45	EL40	40	53	
521		USH23	40	57		

0 0	0 2	0 9	1 0
USH23	30	38	
HOLLYHH33	30	38	
MONOHYE8	30	42	
BETA522	33	32	
MONOHYE4	37	28	
ACH154	37	33	
BETA512	37	38	
USH20A	40	42	
HIMono5419	30	30	
MONOHYE7	30	33	
BETA513	30	33	
MONOHYE4	30	33	
HOLLYHH33	30	37	
HH0459-03	30	50	
HH0452-02	33	37	
HIMono8263	37	40	
BETA533	40	33	
ACH167	40	37	
ACSC81-162	40	37	
GW82MSC161	40	37	
USH23	40	43	
ACSC81-95	40	50	
HIMono8150	40	53	

STATUS OF BEET TISSUE CULTURE AT EAST LANSING

JOSEPH W. SAUNDERS

Recent investigations have centered around the genotype and environmental aspects of high frequency hormone-autonomous callus formation and of subsequent shoot regeneration. Our system involves production of the callus from shoot culture leaf explants. Depending on the cytokinin concentration, shoots are produced in the primary callus culture or in a subsequent one. Genotypes differ in their ability to make the callus and to regenerate shoots, but several germplasm sources of California, Utah, Colorado and eastern U.S. origin, as well as of table and fodder beet, can do both. The callus arises significantly better at 32 C than at 24 C, but this appears to be merely a matter of the high temperature accelerating the formative process: the same quantitative response at 6 weeks at 32 C is obtained after 10 weeks at 24 C.

The major barrier to further progress at this time is the inability of the callus to regenerate shoots after several subcultures. This time frame unfortunately can include the operations involved in protoplast production, fusion, and regrowth. Even starting with genotypes chosen for good regenerating ability, no shoots have been produced from callus derived from individual or fused protoplasts. Dr. Linda Schnabelrauch has conducted the protoplast research, even fusing protoplasts of sugarbeet and Beta corolliflora. In addition, fusion of protoplasts of male sterile and fertile cytoplasms has been conducted. In either case, methodology for sustained shoot regeneration from callus has been lacking.

FIELD EVALUATION OF ROOT/BLADE RATIO SELECTION IN POPULATION AE08 AT SAGINAW, MICHIGAN - 1983

J. Clair Theurer

A study was initiated at Logan, Utah in the winter of 1981-82 to evaluate the merit of selecting plants for high root weight/blade weight ratio in a highly heterogeneous population, AE08. Six seeds were planted in vermiculite in each of 240 4-inch diameter x 7 inch deep tube pots in a sand bench in the greenhouse. Upon emergence, seedlings were thinned to one plant per pot. Each plant received 50 ml of Snyder's nutrient solution daily. The sand surrounding the pots was kept in a moist condition and pots were rotated from front to rear and left to right 2 times/week to maintain as constant environment as possible. Plants were continually illuminated with a bank of fluorescent lights placed 30 inches above the bench giving a light intensity of approximately 200 μE. After 40 days growth each plant was harvested separated into tap root, petiole, and blade and immediately weighed. Approximately 8% of the highest R/B ratio plants (over 1.5 s.d.) were selected for seed increase. A field planting of the R/B selections, the parental population and CMS hybrids was made at the B & B Farm at Saginaw, MI in the spring of 1983. Two commercial varieties USH20, and HH33 were included as checks. At harvest all beets in the plot were weighed for root weight, and samples of brie from duplicate 10 beet samples of each variety or cross were analyzed for sucrose content by the Michigan Sugar Co.

RESULTS

The original population AE08 had similar root weight but significantly less sucrose percentage and gross sugar yield than USH23 (Table 1). AE08 R/B selections #1 and #2 were significantly higher than the parent and USH23 for root weight. They were similar to the parent in sucrose content and significantly better than the parent for gross sugar yield. These R/B selections also had slightly higher sugar yield than USH23. A comparison of AE08 R/B vs AE08 parent crossed with FC606 CMS, also showed the superiority of the R/B selection over the parent population for root weight and potential sugar yield. The AE08 R/B selection #3 consisted of plants that were greater than the mean and as expected did not show the field performance of R/B selections #1 and #2.

DISCUSSION

Data from this experiment indicate that the greenhouse R/B ratio selection method was effective for population AE08. These data support the research of F. W. Snyder concerning the effectiveness of selection for TLWR in EL40.

A study reported in 1978 (See Research Report p B12) on another population showed no differences in root yield but slightly higher sucrose content for the R/B selection vs the parent. Hogaboam also observed no difference in root yield but significantly greater sucrose and clear juice purity in high TLWR vs low TLWR hybrids of selections made from EL40. Two other populations studied at Logan in 1979, and 1980 showed no difference from the parental line. Summarizing data from several experiments we can conclude that R/L selection is effective in some populations but not in others.

Table 1. Root yield, sucrose percentage, and gross sugar for R/B ratic selections and hybrids of population AE08 compared with parent population and equivalent hybrids. - B & B Farm, Saginaw, MI, 1983.

Variety	Root Weight T/A	Sucrose %	Gross Sugar Yield Lbs/A
USH23	19.73	15.75	6204
HH33	18.85	15.27	5715
AE08 Parent	19.74	14.87	5875
AE08 R/B Sel. #1	21.68	14.84	6423
AE08 R/B Sel. #2	21.32	14.89	6346
AE08 R/B Sel. #3	19.38	14.51	5630
USH10♀ X AE08 parent	19.19	15.06	5781
FC606 CMS X AE08 parent	18.66	15.17	5674
FC606 CMS X AE08 Sel #1	21.07	15.06	6337
C16 CMS X AE08 Sel #1	20.88	14.29	5976
Mean	20.05	14.97	5996
LSD .05.	1.60	0.56	510

SELECTION AND EVALUATION FOR PLANT RESISTANCE TO THE SUGARBEET ROOT MAGGOT

J. C. THEURER, G. G. MAHRT, AND A. W. ANDERSON

A continuing cooperative research program to develop resistance to the sugarbeet root maggot (SBRM) Tetanops myopaeformis (Roder) was carried out by G. G. Mahrt, Entomologist, and Agricultural Research Technician, Kimberly, ID, J. C. Theurer, Geneticist, USDA/ARS, East Lansing, MI, formerly of Logan, Utah, and A. W. Anderson, Entomologist, North Dakota State University, Fargo, ND. In 1983 three experiments were conducted at Kimberly, Idaho, and two at St. Thomas, ND. Dr. Theurer, developed the seed, Dr. Mahrt was responsible for conducting the field trials in Idaho, and Dr. Anderson conducted the field trials in North Dakota.

Field trials in 1983 included: 1) an evaluation of the eighth cycle of phenotypic recurrent selection for root maggot resistance in Logan population 25A2; 2) a comparison of several root maggot resistant lines in similar field plots at Kimberly and St. Thomas in an attempt to determine whether or not these two maggot damage areas had the same insect biotype; 3) an evaluation was made of the root maggot damage and yield performance of hybrids made with 25A2 RMR maggot resistant pollen parent.

1. Phenotypic Recurrent Selection

Selection in the heterogeneous population 25A2 was initiated in 1976 and eight cycles of selection have been made to the present date. Each year, a cycle was field tested at Kimberly, resistant roots were selected, induced, and seed increases made at Logan. In 1983, resistant individual C_8 plant progenies were planted in single rows with 10 plants spaced 12 inches apart within the row and 22-inch spacing between rows. The standard susceptible check L19 was again planted at random in the test. A complete randomization of entries was made with 25 replications. Plots were seeded with three seeds per hill and thinned after emergence to a single plant per hill. The plot area at Kimberly had a fairly high natural population of SBRM flies, which was augmented by the release of several thousand captured flies. Stand counts and wilt ratings were taken in mid-July. At the end of July, plants were dug by hand, evaluated for SBRM damage on a 1-5 scale (0=most resistant and 5=dead plant). Results are presented in Table 1.

Significant differences were noted for SBRM feeding damage, wilt ratings and plant stand in comparison with L19. There was

no significant correlation between these variables. Wilt damage was greater in the SBRM selection than in the L19 check. The stand could have been improved by planting more seeds per hill initially. Progress in selecting each cycle from 1976 to 1983 is shown in Table 2. In the first six years of selection there was a gradual increase in resistance of approximately 5% per year. The 1982 evaluation of C_7 with only 1% change from C_6 signaled that the reduction in damage was reaching a plateau. Data this year confirms this premise and shows that further progress cannot be expected in this population by continued phenotypic recurrent selection. Other selection methods and/or new genetic material needs to be introduced into the program to effect further progress toward the development of SBRM resistant germplasm.

Table 1. Mean SBRM rating, wilt rating, and stand for C_8 selections from population 25A2.

Entry	Mean damage rating	Mean wilt rating	Mean stand per plot
1-25A2 low damage	2.46 a[1/]	2.84 b	8.28 b
2-L-19 check	3.26 b	1.68 a	7.24 a
F	53.59**	91.75**	7.76**

1/ Entries not followed by the same letter are significantly different, $P < .05$ as determined by a Duncan's multiple range test, ** = significant at $P < .01$.

Table 2. SBRM ratings as a percent of the parent damage 1976-1983.

	Rating as a Percent of the Parent							
	1976	1977	1978	1979	1980	1981	1982	1983
Low damage selection	96	86	89	81	76	64	63	75

2. Comparison of Sugarbeet Root Maggot Resistant Selections at Kimberly and at St. Thomas

Nine SBRM low damage selections made at Kimberly, Idaho during the past few years, and a high damage selection were zincluded in a randomized block experiment at each location, Kimberly and St. Thomas. Each entry was seeded in hills 12 inches apart in rows 22 inches apart and 10 feet long. At the 4-6 leaf stage the hills were thinned to a single plant per hill. The test at St. Thomas was subject to a natural infestation of flies. At Kimberly the field was supplemented with several thousand additional flies, in addition to the natural infestation. Activity of the flies at both locations occurred over a longer period of time, compared with other years. This was attributed to cool weather during the early part of the growing season. Beets grew well during this period, however, and were larger than the usual size when they were infested by the fly larvae. At St. Thomas a moderate to high level of Cercospora leaf spot occurred in the research plots and no fungicides were applied. At Kimberly wilt ratings were made mid-July based on a 1 to 3 scale with 1 = not wilted, 2 = moderately wilted and 3 = severely wilted. Plants were dug by hand the last week of July and rated on a 0 - 1 scale (lower number = less damage) for SBRM feeding damage. Results at Kimberly are presented in Table 3 and those from St. Thomas in Table 4.

Table 3. Mean sugarbeet root maggot damage rating, wilt ratings and stand for SBRM resistant selections - Kimberly, ID.

Entry	Description	Mean SBRM damage rating	Mean wilt ratings	Mean stand per row	Total plants
1 (40K98)	25A2LD7	2.96 ab[1/]	2.45 c	8.8 c	88
2 (40K130)	40H7 OP	3.08 abc	1.85 b	9.5 c	95
3 (40K135)	40H8 OP	3.56 c	1.31 a	2.2 a	22
4 (40K145)	40G3+a	3.04 ab	1.80 b	8.4 c	84
5 (40K125)	40H8-4XRM20	2.72 a	2.05 bc	7.2 b	72
6 (40K99)	40H7aaXRM13 sib	3.32 bc	1.85 b	7.1 b	71
7 (40K103)	RM5X40H7 Elite X	2.68 a	1.30 a	8.6 c	86
8 (40I55-3)	RM2X40H10-3	3.24 bc	1.65 ab	8.4 c	84
9 (40K52)	40I15+aX40H7	3.33 bc	1.90 b	8.4 c	84
10 (40I10-2)	25A2HD check	4.03 d	1.60 ab	8.6 c	86
F		6.24**	5.19**	27.39**	

(Footnote...see next page)

1/ Numbers not followed by the same letter are significantly different at P < .05 as determined by a Duncan's multiple range test; ** = significant at P < .01.

There were highly significant differences among the entries for SBRM damage, wilting, and stand at Kimberly. Entry 7 had the lowest damage and wilt rating. Entry 10, the high damage check, had the greatest amount of feeding damage which was significantly above that of all other selections. Damage ratings and wilt ratings were not significantly correlated. Further study would be needed to determine the nature of the relationship between wilting and root scarring. Entry 3 had the poorest stand which was due to poor germination and failure of seedling emergence for this seedlot.

Table 4. Mean sugarbeet root maggot damage ratings and stand for SBRM resistant selections - St. Thomas.

Entry	Description	Mean SBRM damage rating	Mean stand 6/16	Mean count 7/15
1 (40K98)	25A2LD7	2.85 a 1/	7.3	7.4
2 (40K130)	40H7 OP	2.61 a	7.0	6.9
3 (40K135)	40H8 OP	2.91 a	2.4	1.8
4 (40K145)	40G3+a	3.00 a	6.5	7.3
5 (40K125)	40H8-4XRM20	2.64 a	4.2	4.5
6 (40K99)	40H7aaXRM13 sib	2.68 a	4.1	4.1
7 (40K103)	RM5X40H7 Elite X	2.58 a	5.2	5.5
8 (40I55-3)	RM2X40H10-3	2.95 a	6.0	6.1
9 (40K52)	40I15+aX40H7	2.94 a	6.2	6.2
10 (40I10-2)	25A2HD check	3.01 a	3.8	3.9

1/ Significance P 0.05 Duncan's multiple range test.

There were no differences among the resistant lines nor the resistant and the high damage check at St. Thomas. However, Entry 7 showed the lowest rating and Entry 10, the highest rating as was observed at Kimberly. The stand and emergence of entry 3 was also poor at this location. The enhancement of fly infestation at Kimberly coupled with the slow emergence of flies at St. Thomas may be the reason that differences were not expressed at the latter station. It was noted that some flies were still active as late as August 2 at St. Thomas. Normally, the middle of June is the peak of fly activity. The data meither support nor disprove the premise that the biotypes of the insect are similar at the two locations.

3. Root Damage Ratings and Yield Performance of Population 25A2 Hybrids

A C_6 SBRM selection from population 25A2 was used as a pollen parent to produce hybrid seed with several CMS inbreds, and single cross seed parents of commercial hybrids. The parent line 25A2, was crossed to the same females in a separate garden seed plot in 1981 to produce equivalent hybrids.

The hybrids and open pollinated progenies of 25A2 RMR and 25A2 were evaluated in replicated field trials at the two locations cited above. Individual field plots consisted of four rows 22 inches apart and 50 ft. long. Each experiment was planted in a randomized block design with 6 replications at Kimberly and 8 replications at St. Thomas. There were eleven entries at each location including a local commercial check, WS76 at Kimberly and ACH30 at St. Thomas. Due to insufficient seed of 2KX5, for planting at both locations, 2KX3 was used in place of 2KX5 at Kimberly. Otherwise the entries were identical.

In late July a sample of roots was dug from the two outside rows of each plot and scored for root maggot damage. The center two rows were harvested in late September at St. Thomas and mid-October at Kimberly for root weight. Sucrose percentage was also determined for the Kimberly experiment by the Amalgamated Sugar Co. Results are presented in Table 5 for Kimberly and Table 6 for St. Thomas.

Table 5. Sugarbeet root maggot resistance rating, root yield and sugar percentage of 25A2 and 25A2 RMR hybrids, Kimberly, ID, 1983.

Entry	Description	Mean SBRM damage ratings	Mean wilt ratings	Mean yield per 100 ft. (lb)	% sugar
1 (2K2)	25A2	2.1	2.17 d[1/]	229.71 b	13.64 abc
2 (2KX1)	10♀ X 25A2	2.0	1.92 cd	277.33 cd	13.30 a
3 (2KX2)	20♀ X 25A2	1.6	1.42 ab	299.92 de	13.50 ab
4 (2KX3)	8♀ X 25A2	1.7	1.67 abc	277.25 cd	14.44 abc
5 (2KX4)	C16 X 25A2	1.7	1.25 a	319.08 e	13.18 a
z6 (40K150)	25A2 RMR	1.9	3.00 e	128.92 a	15.55[2/]
7 (40K148)	10♀ X 25A2 RMR	1.7	1.83 bcd	258.38 bc	14.35 abc
8 (40K152)	20♀ X 25A2 RMR	1.9	2.25 d	290.88 cde	15.05[2/] c
9 (40K149)	C16 X 25A2 RMR	1.8	1.83 bcd	297.83 de	14.55[2/]
10 (40K151)	L53 X 25A2 RMS	1.5	2.17 d	229.63 b	15.41[2/]
11 (AM14)	WS76	1.8	1.58 abc	291.79 cde	14.81 bc

(Footnotes...see next page)

1/ Numbers not followed by the same letter are significantly different at P < .05 as determined by Duncan's multiple range test.

2/ Not included in analysis because there were less than 3 replications of percent sugar received from The Amalgamated Sugar Co. tare lab.

Table 6. Sugarbeet root maggot resistance rating, and root yield of 25A2 and 25A2 RMR hybrids, St. Thomas, 1983.

Entry	Description	Mean SBRM damage rating	Mean yield tons/A	Mean leaf spot rating
1 2K2	25A2	3.13 e[1/]	20.15 d	7.0
2 2Kx1	10♀x25A2	3.03 cde	26.67 ab	6.7
3 2Kx2	20♀x25A2	3.10 de	26.63 ab	5.6
4 2Kx4	C16x25A2	2.75 abcd	26.07 ab	5.6
5 2Kx5	L53x25A2	2.88 bcde	24.54 bc	6.5
6 40K150	25A2 RMR	2.83 bcde	15.35 e	5.8
7 40K148	10♀x25A2RMR	2.69 abc	24.93 bc	5.2
8 40K152	20♀x25A2RMR	2.78 abcde	27.36 a	4.7
9 40K149	C16x25A2RMR	2.83 bcde	25.84 abc	5.1
10 40K151	L53x25A2RMR	2.60 ab	21.21 d	7.3
11 -	ACH130	2.43 a	23.78 c	4.8

1/ Numbers not followed by the same letter are significantly different at P < .05 as determined by a Duncan's multiple range test.

There were no significant differences among the entries for SBRM damage at Kimberly. In particular, we would have expected to observe a lower rating for 40K150, the C_6 SBRM selected genotype. Dr. Mahrt noted that the large block plantings appeared to spread the available fly larvae over more roots giving considerably lower rating scores than observed in space planted material. All of the damage ratings in the other Kimberly tests are significantly higher (Tables 1 and 3) than observed in the hybrid test (Table 5). Although it was felt there was a moderate to heavy infestation of flies in the plot area, it may be that there was insufficient numbers of larvae feeding on the roots to distinguish differences. At St. Thomas significant differences were observed between the entries for SBRM rating, with the locally adopted commercial variety, ACH30 showing the lowest score. The resistant 25A2 RMR and hybrids with this line had slight but non-significantly lower score than the 25A2 parent and non-SBRM selected hybrids.

Selection 25A2 RMR (seed no. 40K150) plants were weak and spindly and showed the greatest amount of wilting at both locations. As expected, inbreeding depression was observed in population 25A2 material in C_3 and C_4 selection cycles, however C_4, C_5, and C_6 selections had similar canopy appearance. The 40K150 genotype was completely different from the C_6 parent plants which had shown good canopy appearance with no evidence of wilting in the space planted nursery in 1981. Also we noted that the C_8 plant material of 25A2 had considerably better canopy than 40K150 in another test at Kimberly in 1983. These observations suggest there may have been an error in planting seed for steckling or in transplanting steckling to the garden isolation seed increase plot. If so, the 40K150 seed and hybrids may not be the root maggot resistant material they were supposed to be.

Significant differences were noted for root yield at both locations (Tables 5 and 6). In general, the yields of the 25A2 hybrids were greater than the 25A2 RMR hybrids. Inbreeding depression and selection only for SBRM resistance resulted in a loss of genetic factors enhancing yield. The 25A2 RMR hybrids showed a tendency to have a higher sugar percentage than 25A2 hybrids.

DISCUSSION

Selection for resistance to the sugarbeet root maggot looked very favorable from the standpoint of the average 5% per cycle reduction in SBRM feeding damage realized the first 6 cycles of selection in population 25A2. Data from the C_7 and C_8 cycles indicate that the maximum amount of progress that can be made by phenotypic recurrent selection has been attained. No further selection cycles are warranted.

The 25A2 resistant selection 40K150 showed poor performance in the 1980 field trials cited herein. However these data should not be construed to conclude that good germplasm cannot be developed from the 25A2 population source. From the original population and several other cycles we have selected plants and developed progenies that have exhibited good progeny performance for SBRM resistance. In 1979 we crossed the most SBRM resistant genotypes in our program with the most SBRM resistant genotypes that Amalgamated Sugar Co. had developed from their breeding material. In 1980 field evaluations, three of the F_1 progenies had ratings of less than 1.0, and 9 others were rated between 1.0 and 1.5. The genotype 40G1 has shown good potential as a parent of productive hybrids. (See Table 7, page B50, 1981 Report). Other resistant selections have not been evaluated for combining ability and yield performance. Curly top resistance has been incorporated into some of the SBRM resistant material.

Research the past few years has demonstrated that the inheritance of root maggot resistance is complex. We recommend the following for future research to develop plant resistance to the sugarbeet root maggot: 1) Search for new sources of resistance to incorporate into the program, 2) Use recurrent selection techniques for breeding resistance, 3)Develop greenhouse or controlled chamber methodology to control the variables of temperature, moisture, fly population, planting date, etc. to make accurate evaluations on maggot damage and eliminate the extreme year to year variation observed in field plots.

Upon termination of the Logan, Utah USDA-ARS Research Station, all of the germplasm developed at Logan has been transferred to the Fargo, ND Sugarbeet Research Unit. Dr. Devon Doney and Dr. Larry Campbell will continue the research on sugarbeet root maggot resistance.

BREEDING SUGARBEETS FOR RESISTANCE TO BLACK ROOT AND LEAF SPOT

G. E. Coe

Research work on sugarbeets at the Agricultural Research Center, Beltsville, Maryland is directed toward improvement of sugarbeet germplasm resistant to Aphanomyces blackroot and Cercospora leaf spot, important diseases in eastern United States. Much effort is now directed toward producing germplasm with "soil-free" taproots to eliminate mechanical cleaning and for possible use in commercial transplanting operations. In addition, research and development is being conducted to produce: 1) germplasm with resistance to southern root rot (Sclerotium rolfsii) for use in southern U.S. where this disease is endemic; 2) germplasm with a low content of nonsucrose solubles; and 3) germplasm combining high root tonnage with reasonable sucrose percentage for fuel alcohol production.

Testing for Leaf Spot Resistance

The Beltsville leaf spot epidemic this year was quite good and prolonged. The epidemic in the late planted nursery was about two weeks behind the early planting but became just as severe by September 12. The breeding lines were more severely infected in 1983 (Table 1) than in 1982, but were considerably more resistant than USH20 and several were as resistant as our resistant check.

TABLE 1. Results of Beltsville leaf spot tests in 1983

Description	No. lines Tested	Av. Leaf Spot Rating*		
		Breeding Lines	USH20 Check	Resistant Check
Beltsville MM BRR-LSR lines from BRR Selections	59	3.4	5.2	2.2
Beltsville MM BRR-LSR lines from LSR Selections	6	2.7	5.2	2.2
East Lansing MM lines	59	3.3	5.7	2.3
Beltsville mm lines	30	2.5	4.7	1.7
East Lansing mm lines	126	3.4	5.2	2.5
Beltsville "Soil-free" MM	139	3.7	5.2	2.5

*0 = No spots; 10 = All leaves dead.

The mm lines from Beltsville were more resistant than any other group in the nursery. The slower buildup of Cercospora in this experiment resulted in less disease in both the resistant and susceptible checks. In spite of our decreased emphasis on selecting for leaf-spot resistance and more

emphasis on better yield, sucrose percentage, and (lower) percentage of nonsucrose solubles, some gain has also been achieved in leaf spot resistance.

Testing for Black Root Resistance

It isn't possible to have precise control over the severity of the blackroot epidemics in our greenhouse tests. Hence, if we are only realizing light infestations at the time we happen to be testing monogerm lines they may have better (lower) numerical ratings than multigerm lines tested at a time when more severe epidemics were being achieved. Such was the case in the data presented in Table 2.

TABLE 2. Results of testing 1982 seed production for BRR

Description	No. lines Tested	Av. Black Root Rating*		
		Tested Lines	Resistant Check	Susceptible Check
MM from BRR Selections	208	104	100	108
MM from LSR Selections	36	103	100	104
Beltsville mm lines	42	97	100	102
MM-TLWR Selections	48	101	100	104

*110 = Death of all plants; 68 = No infection.

The severity of the epidemic is indicated by the numerical rating of the susceptible check. Thus the multigerm lines coming from roots selected for black root resistance (first line in Table 2) underwent severe epidemics as indicated by the 108 average disease rating for the susceptible check. The resistance of these breeding lines with an average rating of 104 is actually better than the resistance of the multigerms on line 2 of Table 2 which have an average rating of 103 since the severity of the epidemics was less as indicated by the 104 rating of the susceptible check. All ratings are relative to the resistance of the resistant check variety which is arbitrarily given a rating of 100. With increasing resistance of the breeding lines it has been necessary to change the variety used as the resistant check every 4 or 5 years. If US 400, our black root resistant variety of 25 years ago, were placed in today's greenhouse tests, it would appear to be quite susceptible. One breeding line in the 1982-83 tests appeared to be almost immune.

A New Disease Resistant Multigerm Pollinator

Two pollinator lines were used across a series of 9 cytoplasmic male-sterile lines: 1) SP79260-0 is a pollinator with black root and leaf spot resistance at least as good as SP6822-0; 2) SP82250-0 (seed increase of SP76250-237) is a pollinator known to have very good leaf spot resistance. The eighteen hybrids were tested in our greenhouse for resitance to blackroot and at both Beltsville and East Lansing for leaf spot resistance. Yield data were also obtained from the B. & B. farm in Michigan. Results of the disease tests are presented in Table 3.

TABLE 3. Disease test results of 2 pollinators crossed cnto 9 male-sterile lines.

Male-sterile	Av. Beltsville Leaf Spot Readings*		E. Lansing Leaf Spot Readings*		Black Root Test Ratings**	
	76250-237PF	82260-0PF	76250-237PF	82260-0PF	76250-237PF	82260-0PF
# 1	3.3	4.0	3.0	3.0	95	98
# 2	3.3	3.7	2.7	3.0	100	105
# 3	3.0	3.3	2.3	3.0	104	102
# 4	2.7	3.7	2.3	3.0	101	102
# 5	2.7	3.3	2.7	3.0	100	103
# 6	3.0	3.7	2.3	3.0	100	100
# 7	3.7	3.7	3.0	2.7	92	103
# 8	3.0	4.0	2.3	3.0	96	102
# 9	3.3	4.0	2.7	3.0	101	105
Average	3.1	3.7	2.6	3.0	99	102

*0 = No spots on leaves; 10 = All leave dead.
**130 = Death of all seedling; 78 = No infection.

From Table 3 it is obvious that the hybrids having 76250-237 as pollinator were more resistant to leaf spot at Beltsville than those having 82260-0 as the pollinator except for male-sterile line #7. At East Lansing the hybrid from male-sterile line #7 crossed with SP76250-237 was less resistant to leaf spot than the hybrid male-sterile #7 X SP82260-0. The hybrids from male-sterile line #1 tested at East Lansing showed no difference in leaf spot resistance. We can conclude that SP76250-237 conferred more leaf spot resistance in most hybrid combinations than did the other pollinator in this test. The 9 hybrids having this pollinator were more resistant at Beltsville than hybrids in this test having SP6822-0 as the pollinator.

In addition, our greenhouse tests indicate SP76250-237 conferred more resistance to black root than did SP82260-0. It has had more cycles of selection for black root resistance than has SP82260-0. With respect to recoverable sugar per acre at Michigan's B. & B. farm, there wasn't a trend favoring hybrids from either pollinator. However, hybrids from SP76250-237 generally had a little higher root tonnage and a little lower sugar percentage than hybrids from 82260-0. Most of the hybrids produced less sugar per acre than USH20, but the 2 hybrids from male-sterile #9 performed reasonably well, especially male-sterile #9 X SP76250-237.

Selecting for Resistance to Southern Root Rot

Progenies from second and third cycle selections for resistance to southern root rot, Sclerotium rolfsii, were tested in the winter of 1983 and 1984. Progenies of second cycle selections known to have good resistance were used as the checks against which the test progenies were compared in order to make it difficult for the test progeny to receive a good rating. Results of these tests completed to this date are presented in Table 4.

TABLE 4. Results of testing 1983 seed productions for resistance to southern root rot.

Southern Root* Root rating of Parent Plant	No. of progeny apparently having More Resistance	Equal Resistance	Less Resistance
1 or 2	23	15	14
3 or 4	2	5	5

*1 = Almost no infection; 5 = Plant dead.

We selected plants with considerable infection (Rated 3 or 4) but which seemed to recover from the disease very well after transplanting to the field, thinking that perhaps they were really resistant and that selected plants with more apparent resistance (Rated 1 or 2) might have simply escaped severe infection. This year's results indicate that regardless of the apparent resistance of the selected plant some progenies will not be as resistant as their parent lines. On the other hand, the selected plants with the best apparent resistance, produced a much higher percentage of progenies with better resistance. Reasonable progress is being made in improving resistance to this disease.

Testing for Low Content of Nonsucrose Solubles

An experiment was conducted in 1983 to test the effectiveness of our selection for lower the content of nonsucrose solubles (NSS). Progenies of selected plants were planted in alternate rows with a progeny from a plant with average content of NSS. SP8222-0, a descendant of SP6822-0 with no selection for NSS, was planted in the border row on each side of the experiment. The rows were 4 ft. apart, and the hills were spaced 3 ft. apart with 2 plants about 10 inches apart in each hill. This spacing was used to reduce competition and to test, in 1985, the effectiveness of selecting between the paired plants in each hill. Results of the 1983 test are presented in Table 5.

TABLE 5. Results of progeny test for low content of nonsucrose solubles.

Seed Number	Harvest Date of Tested Line: No. Plants Analyzed	Av. Rt. Wt.	Av. % Sucrose	Av. % NSS	Data of ♀ Parent Plant: Rt. Wt.	% Sucrose	% NSS
8222-0	123	3.59	14.47	2.87	No Data - This is Open-pollinated line.		
82351-5**	123	3.91	14.98	2.61	3.3	13.9	2.86
82350-10*	105	3.62	15.57	2.18	5.0	14.8	1.59
82350-11*	66	2.78	13.68	2.22	6.3	13.1	1.86
82350-6*	64	4.31	14.47	2.34	3.6	14.7	1.63

* = Progeny of plants selected for low content of NSS.
** = Progeny of plant selected for average content of NSS.

In Table 5 the average percent of NSS for the 3 progenies of plants selected for this characteristic contained only about 85% as much NSS as the progeny of the plant selected for average content of NSS and 78% as much as SP8222-0. It isn't known why the average root weight of 82350-11 is low compared to the plant which produced this progeny. The experiment indicates that the amount of NSS has been decreased. Seed increase will be made of roots selected from these progenies. A separate increase will also be made of the companion plants from the same hills as the selected plants to determine if this increases the efficiency of the selection technique.

Development of Soil-Free Sugarbeet Taproots

"Soil-free" breeding lines continue to exhibit slow improvement. They have a higher percentage of roots with less adhering soil, and the best ones are better than the best ones of 2 or 3 years ago. In Table 6, 135 selected soil-free roots are compared with 91 selected roots from our leaf spot

resistant and black root resistant breeding lines growing in adjacent experiments.

TABLE 6. Comparison of selected roots from soil-free and BRR-LSR breedings lines.

	Soil-Free Selections	BRR-LSR Selections
No Roots Analyzed	135	91
Av. Leaf Spot Rating*	3.37	3.37
Av. Root Wt.	2.23lbs	3.36lbs.
Av. % Sucrose	13.04%	13.85%
Av. % NSS	2.47%	2.89%
Av. Raw Juice Apparent Purity	84.07%	82.73%

*0 = No spots; 10 = All leaves dead.

Since the average leaf spot ratings for the 2 groups are the same, leaf spot should have had about equal detrimental effect on both groups. The soil-free roots were only slightly smaller than the "normal" sugarbeets, but they were lower in sucrose by .81 percentage point. With the emphasis on selection for soil-free root type the sugar percentage of the soil-free lines is increasing only very slowly. (They started from a much lower point as a result of having come from sugarbeet X garden beet crosses.) Note, however, that the percentage of nonsucrose solubles is considerably lower in the soil-free lines resulting in a higher raw juice apparent purity. This means a smaller loss of sugar to molasses, but the soil-free beets are still not usuable because they yield less sugar per acre and less sugar per ton of beets. Sugar percentage must be increased before they are acceptable.

Sugarbeet X Fodderbeet Crosses

Sugarbeet X fodderbeet crosses and their reciprocals were originally made at Beltsville to produce a beet variety with high per acre sugar yields usuable for fuel alcohol purposes. Such a variety was predicted to have rather low sugar percentage with an unpredictable content of other solubles in the juice. F_2 populations of these crosses were grown in the nursery in 1983 and selected roots were analyzed for sucrose and total solubles. Roots were selected from an adjacent experiment containing multigerm progenies from East Lansing. Results of the analyses are presented in Table 7.

TABLE 7. Analyses of selected roots of F_2 populations of sugarbeets X fodderbeets, their reciprocals, and sugarbeets.

Description	No. Roots Analyzed	Av. Lbs. Rt. Wt.	Av. % Sucrose	Av. % NSS*
Sugarbeet progenies from East Lansing	96	4.05	13.96	2.54
F_2 plants of sugarbeet X fodderbeet	66	6.51	12.45	2.61
F_2 plants of fodderbeet X sugarbeet	91	8.69	9.76	2.84

*NSS = Nonsucrose solubles.

The high average weight of the F_2 roots of fodderbeet X sugarbeet was due at least in part to the thin stands of most of these populations. Likewise, their low sugar content and higher NSS are partly attributable to poor stands. The other 2 classes of plants in Table 7 had very good stands in the nursery plots. Since these were not replicated tests, because of unequal competition, and because of the poor stands in the F_2 of the fodderbeet X sugarbeet root yields were not taken. It is safe to say, however, that the root weight of the F_2 populations of the sugarbeet X fodderbeet were at least 25% greater than the multigerm in the adjacent experiment. In addition the 10 roots having the highest sucrose percentage in the F_2 population of sugabeet X fodderbeet compared rather favorably with the 10 sugarbeet roots having the highest sucrose percentage especially when their root weights are taken into consideration (Table 8).

TABLE 8. Comparison of roots with best sucrose percentage among sugarbeets and F_2 sugarbeet-fodderbeet crosses.

Description	Root Weight lbs.		% Sucrose		% NSS*	
	Range	Av.	Range	Av.	Range	Av.
Sugarbeets	2.0-4.3	3.36	15.4-17.1	16.09	1.57-3.55	2.33
F_2 of Sugarbeet X fodderbeet	4.3-6.2	5.15	14.7-16.6	15.29	1.74-2.87	2.26

*NSS = Nonsucrose solubles.

It appears that there is excellent opportunity to select among the F_2 populations of sugarbeet X fodderbeet and increase root tonnages dramatically without very much sacrifice of sucrose percentage and without any increase in nonsucrose solubles.